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HIGH GRADE WELDING AND CUTTING APPARATUS :-: PORTABLE AND GENERATOR OUTFITS :-: WELDING RODS, FLUXES AND ACCESSORIES

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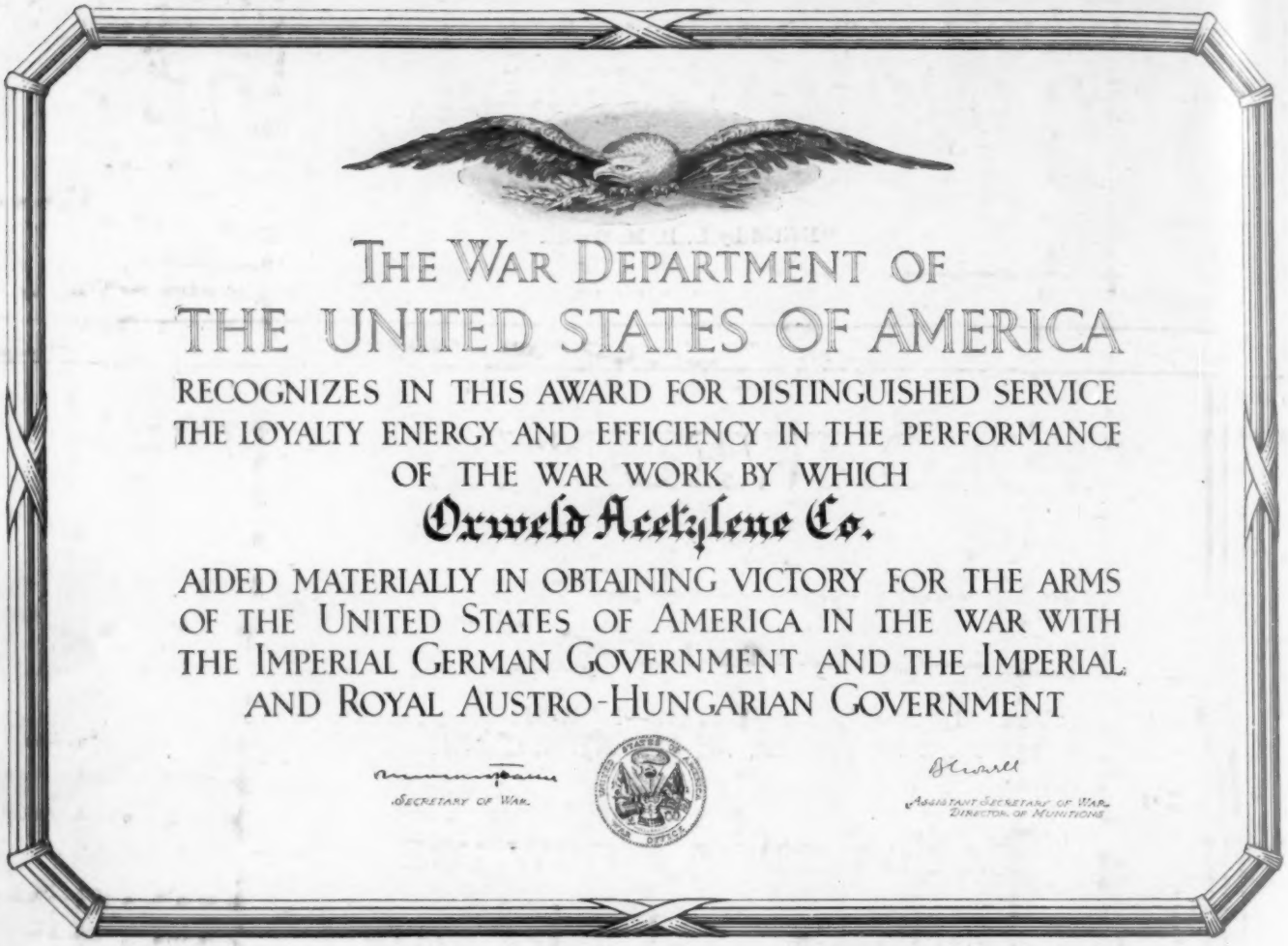
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Commercial Acetylene Welding Co.
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See "Torches"

BOOKS (Relating to Welding)
The Welding Engineer
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See "Torches"

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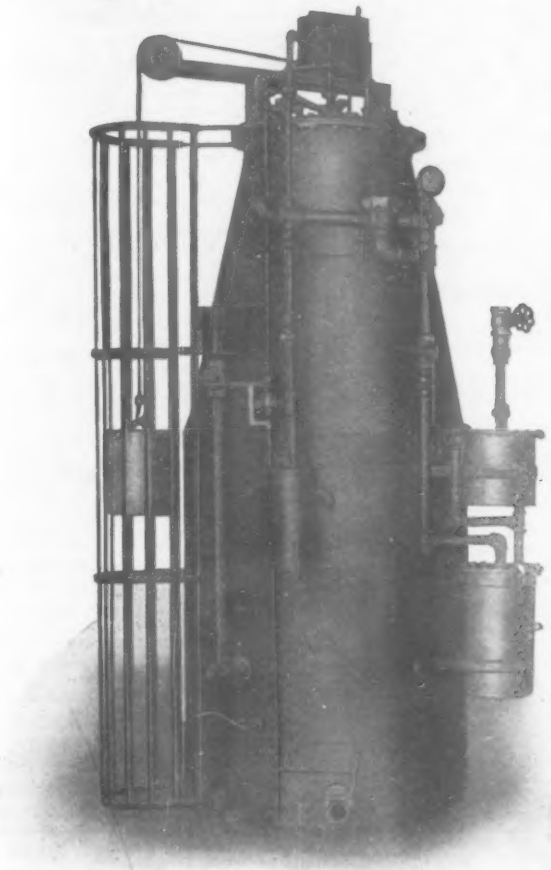
Acetylene for Welding and Cutting



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Made in four sizes, for 50 lb., 100 lb., 200 lb. and 300 lb. of carbide, with normal output of 50, 100, 200 and 300 cubic feet of acetylene per hour, as authorized by the Underwriters. We have discontinued smaller sizes as impractical for the general repair shop or metal-working plant.

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Weldit Acetylene Co.

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Harris Calorific Co.
International Oxygen Co.
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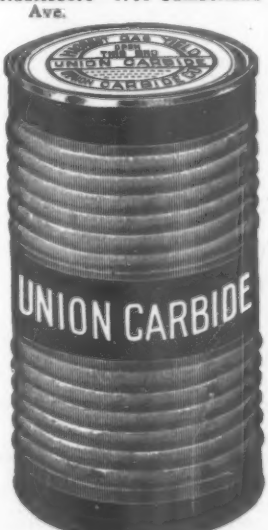

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Springfield—Napier St.
Worcester—15 Federal St.

Michigan
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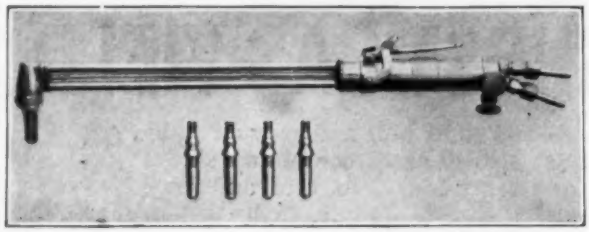

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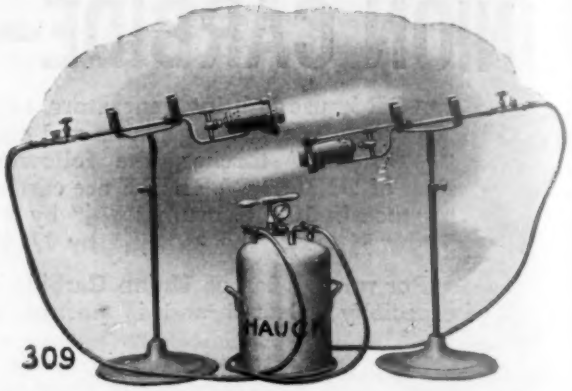

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The heat was confined by building a furnace of loose fire brick and sheet asbestos around the break. A cherry red heat was secured in 1½ hours' time, with a consumption of 7 gallons of kerosene.

After the weld, these burners were used to reheat the press, which was then cooled gradually.

Hauck Double Burner Preheaters are described in Bulletin No. 103. *Write for your copy today.*

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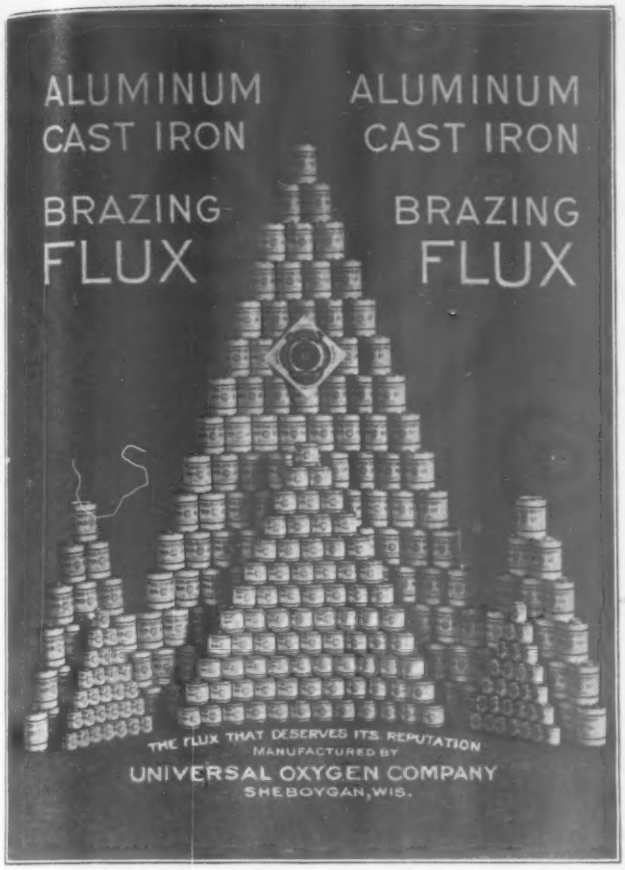

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QUALITY GUARANTEED

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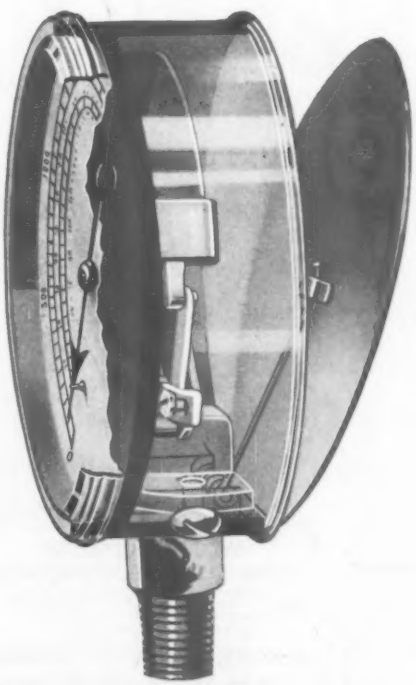

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Parsons' Manganese Bronze Rolled Welding Rods

the Strongest Bronze Made

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PACKED IN BROWN DRUMS

For Acetylene Compressing Plants, Oxy-Acetylene Welding Plants, House Lighting Generators, Contractors' Torches, Etc.

IN 100 lb. DRUMS

In All Commercial Sizes:

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MIXING CHAMBER ALWAYS COOL
NOZZLES CHANGED WITHOUT WRENCH
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And are revolutionizing all existing ideas of performance of torches, and are bringing new surprises in their accomplishments, to their users every day.

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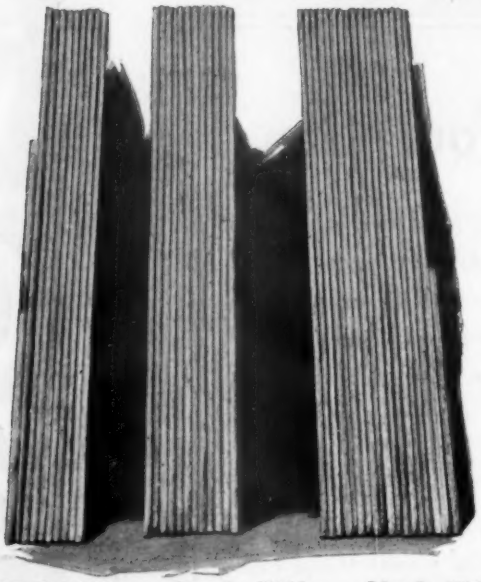
LINCOLN ARC WELDER

Lincoln Welder Melts More Metal



Welder "A"	Lincoln Welder	Lincoln Welder
Rating 200 Amperes (½ hour intermittent)	Rating 150 amperes (continuous welding duty)	Rating 200 Amperes (continuous welding duty)
9¾ pieces per hour	12 pieces per hour	17½ pieces per hour

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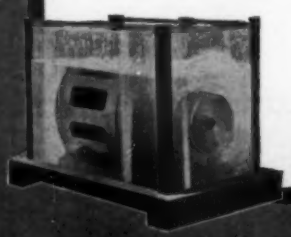
This Standard Lincoln Motor operated over 3 years under water without damage.



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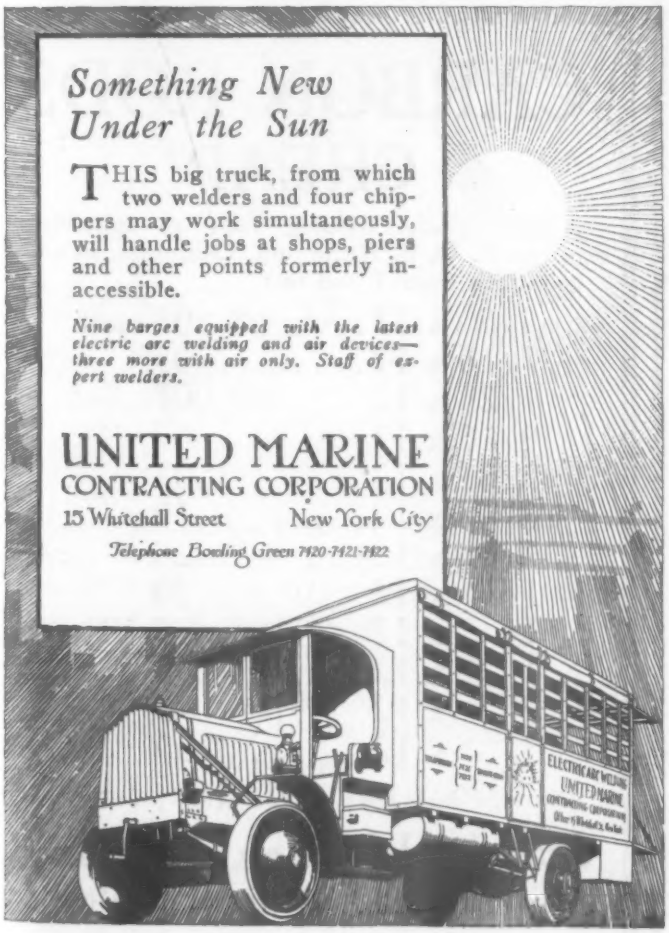

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It Pays to Use Only the Best

Better, stronger and softer welds are more easily and more quickly made with Anti-Borax Welding Fluxes. That's real economy.

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rum after drum – the uniformly high quality of the millions sold, has given

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a reputation that makes the dealer glad to sell and the customer insist on the kind that *does* give *"More Gas per Pound"*

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3/8	x 12.....	$ .05	each
7/16	x 12.....	.05	"
1/2	x 12.....	.07	"
9/16	x 12.....	.07	"
5/8	x 12.....	.07	"
3/4	x 12.....	.10	"
7/8	x 12.....	.20	"
1	x 12.....	.20	"
1¼	x 12.....	.35	"
1½	x 12.....	.50	"
2	x 12.....	.75	"
3	x 12.....	1.50	"

For 24 inch rods double these prices.

Standard Carbon Company
R. F. D. 38A - Richmond, California

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—why not get the Best Regulator?

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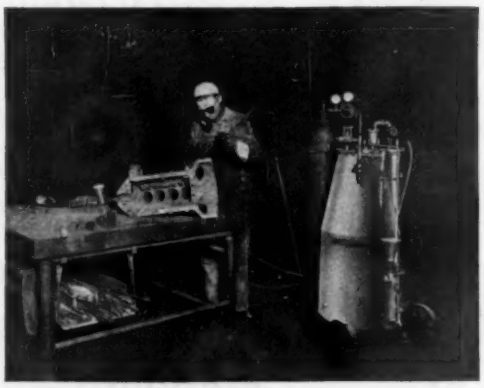

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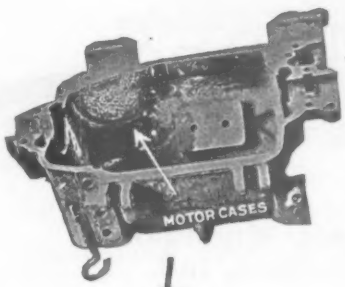

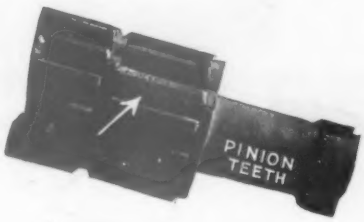

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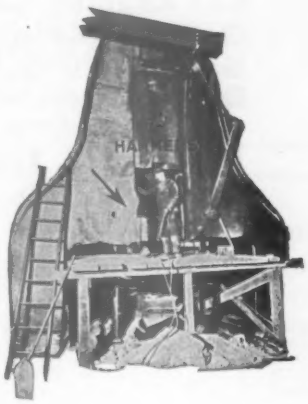

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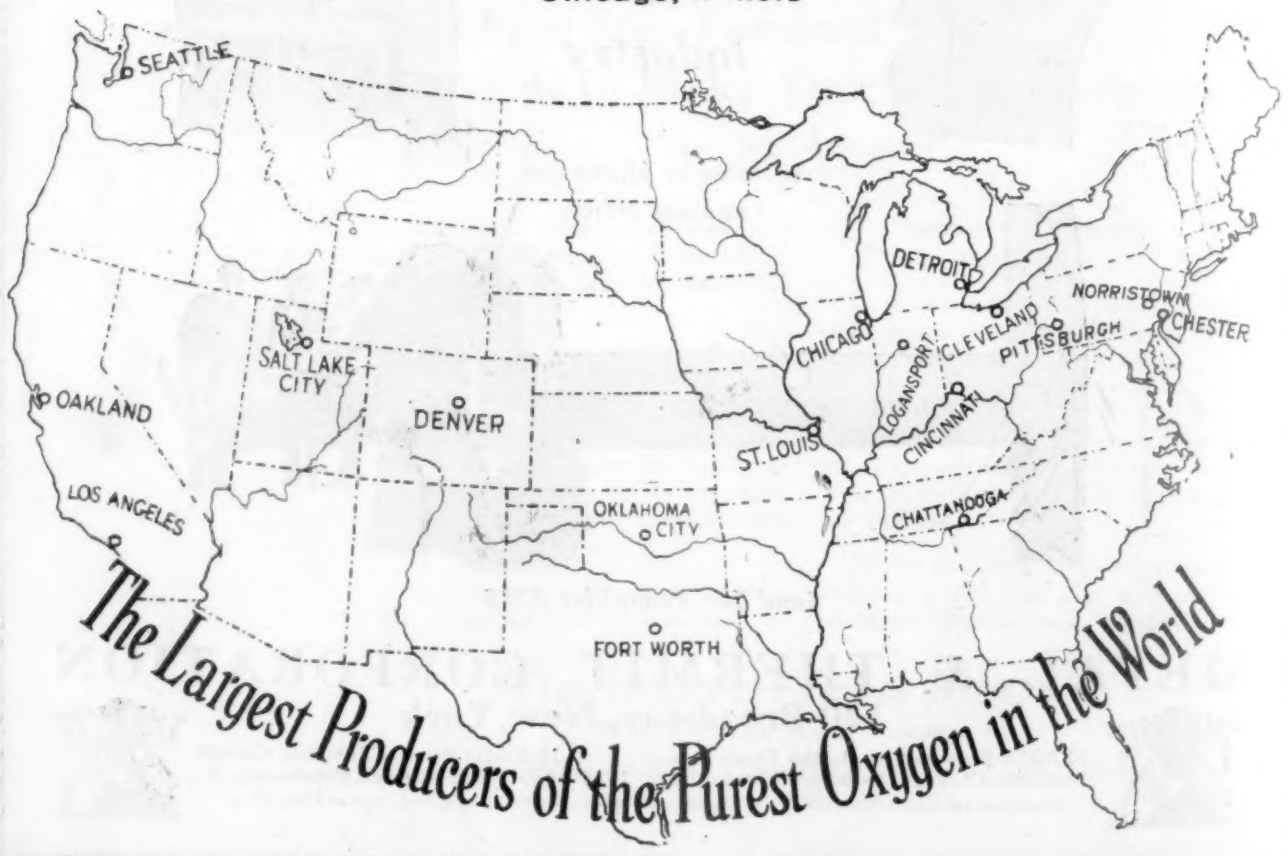

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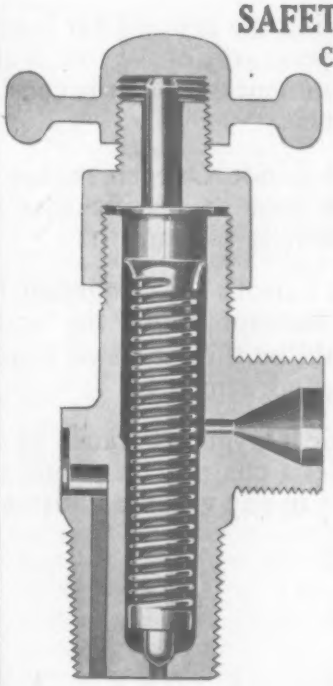

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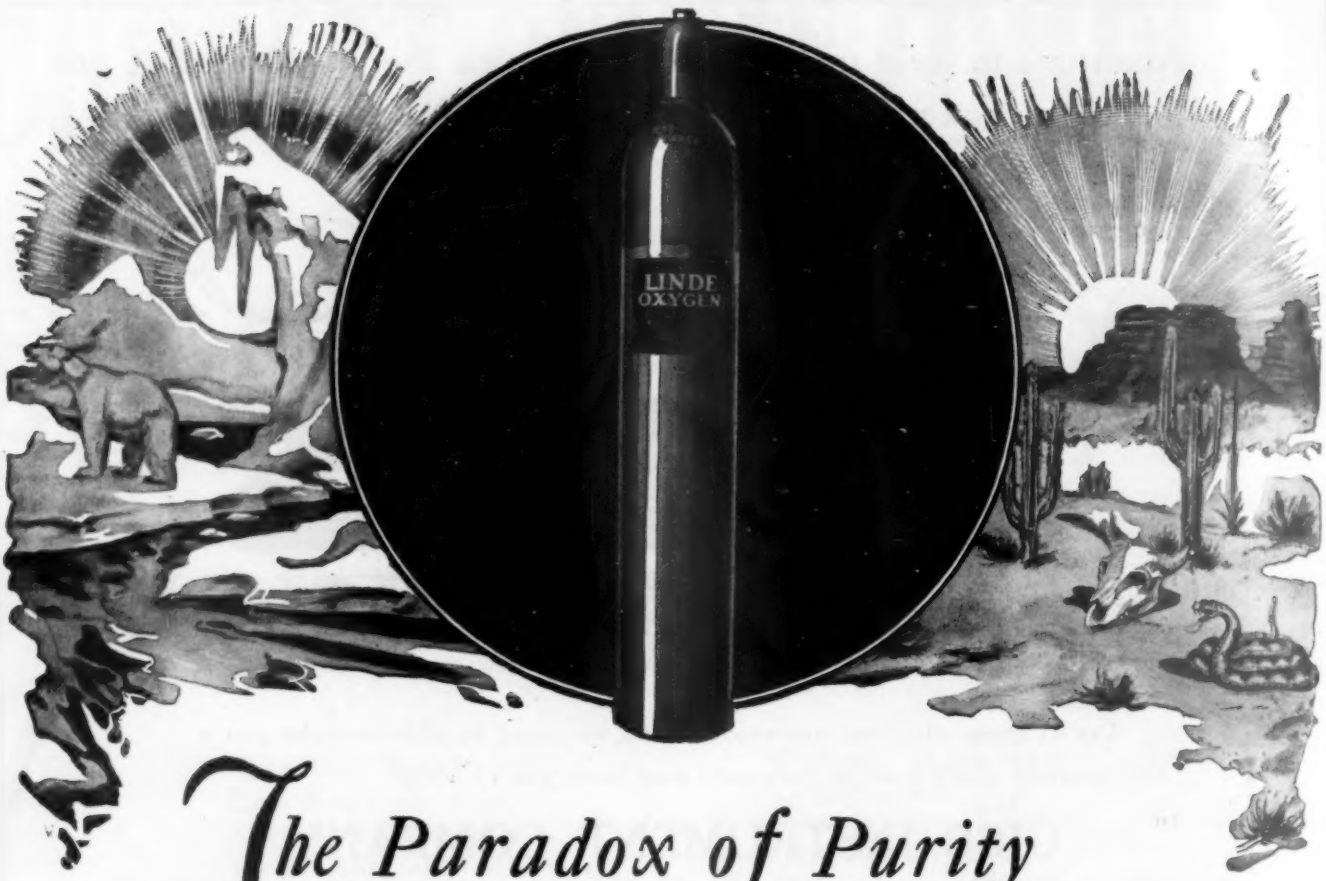

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PROCEEDINGS *of the* AMERICAN WELDING SOCIETY

33 West 39th Street, New York

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AMERICAN WELDING SOCIETY
1920—1921

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C. A. Adams, Junior Past President
J. W. Owens, Vice-President
D. B. Rushmore, Vice-President
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C. A. McCune, Chairman Membership Committee.
Edward A. Miller, Chairman Meetings and Papers Committee.
A. S. Kinsey, Chairman, Welding Conference Committee.

AMERICAN WELDING SOCIETY

Owing to the recent gratfying progress made by the American Welding Society in increasing its membership and in the formation of sections in different cities, the present is an opportune time for giving an account of the Society since its formation: the circumstances which led to its organization, its activities thus far, and its hopes for the future. It is hoped that this will be of interest to the old members as well as the recent ones, will serve to crystallize in the minds of all the purposes which bind us together. Consequently, it has been decided to omit from our Proceedings this month, the usual publishing of "papers"; and to substitute a short "history" of the Society.

The American Welding Society came into being in the following manner:

During the war, The Emergency Fleet Corporation formed a Welding Committee, composed of a body of experts on the subject of welding in its various branches and phases. It comprised representatives from this country and England, from the Army and Navy, from Educational Institutions, from the Marine Underwriters, Ship Builders, and other manufacturers. With the close of the war, when the Government withdrew from the activities created by it, this organization, like so many others, was left with important work uncompleted. This represented a great amount of effort, not to speak of its cost in money. The desirability that this work be continued, led to the organization of the American Welding Society. Its actual organization was accomplished chiefly by the members of the former Welding Committee of the Emergency Fleet Corporation. Delegates were invited from the leading Scientific Societies and from Governmental Departments acting not merely as individuals, but as representatives of their respective organizations to come together with the representatives of the American Welding Society to form a permanent organization to be known as the American Bureau of Welding. The functions of the latter are to establish and standardize the facts, to conduct such researches as may be needed, and thus furnish a sound basis for the development of an industry bound to be of the first magnitude. Among the personnel of the American Bureau of Welding are to be found the individuals, and in the laboratories of its component organizations is to be found the equipment necessary for conducting any research work that the Society may be called upon to conduct or to co-operate in.

The bodies at present composing the American Bureau of Welding are the following:

American Bureau of Shipping
American Electro-Chemical Society
American Engineering Standards Committee
American Institute of Electrical Engineers
American Institute of Mining and Met. Engineers
American Physical Society
American Society of Civil Engineers
American Society of Mechanical Engineers
American Society of Refrigerating Engineers
American Society for Testing Materials
American Welding Society
Bureau of Standards, U. S. Dept. Commerce
Bureau Veritas
Engineering Foundation
Federal Board of Vocational Education
Lloyd's Register of Shipping
National Fire Protection Association
National Research Council
New York Academy of Sciences
Society of Automotive Engineers, Inc.
Society of Naval Architects and Marine Engineers
U. S. Navy Dept., Bureau of Construction
U. S. Navy Dept., Bureau of Ordnance
U. S. Navy Dept., Bureau of Steam
U. S. Shipping Board
U. S. War Department

The American Bureau of Welding is the authoritative body to establish the facts. In order that the Bureau may function to better advantage, the "Proposed New Organization of the American Bureau of Welding," that appeared as a part of the October "Proceedings," was prepared by Prof. C. A. Adams, Director of the Bureau.

In the October Proceedings, the article regarding the American Bureau of Welding, which has just been referred to, followed an article entitled "National Research Council" which had also been prepared by Prof. Adams, who, besides being Director of the American Bureau of Welding, is also the Chairman of the Engineering Division of the National Research Council.

The article on the National Research Council standing by itself does not make clear its relation to the American Welding Society; whereas, this point is covered in the second paragraph of the article on the American Bureau of Welding. This relation is that the Bureau shall be the General Welding Research Advisory Committee, *both* of the American Welding Society and of the Engineering Division of the National Research Council.

To make the most of the facts gathered by the American Bureau of Welding and the National Research Council requires still another sort of machinery and the organization that does

this is the American Welding Society. Its function is not to supply the knowledge but to spread it and assist in putting it to practical uses. It is the Society, for instance, which publishes the Proceedings which will push matters of importance to welding and which will open out new fields for its use. It holds regular meetings to discuss matters relating to welding, to act upon the recommendation of the Bureau and to initiate further activities.

This division of the work, while it has created some confusion on account of the similarity of the names, is a logical one, and will be found effective in operation as was clearly indicated by the experience with the old Welding Committee.

The foregoing then explains how the American Welding Society came into existance, and shows its connection with and relation to the American Bureau of Welding and the National Research Council.

Before going further, it may not be amiss to quote bodily at this point, the article by Prof. Comfort A. Adams, the first president of the American Welding Society entitled "OUR PERSPECTIVE", which opened the first issue of the publications of the Society.

"The whole civilized world is in a state of ferment. What is the cause? Some tell us that it is the war, but is this not a superficial explanation? Was not the war merely a stimulus or aid to the fermentation already started? The fact is that the work of the engineer has brought the ends of the earth closely together—has made the nations of the earth inter-dependent. This made large combinations or organizations of all kinds not only possible but necessary. As yet the human race has not learned how to control the power of these enormous organizations, whether of nations, of capital, or of labor. We have not learned yet how to make them serve society and thus make the world a better place to live in.

"The great war is over but the spirit of war still prevails. The only difference is in the size of the units involved—whether they be nations against each other, organizations of capital against each other, organizations of capital against organizations of labor, or even a struggle between organizations of labor, each trying to raise its own head above that of the others.

"But how futile all this is, for it is nothing more than a struggle on the part of each group to get a larger share of the wealth produced by them all, a struggle to get up by climbing on the other fellow's back, to get something by taking it away from the other fellow. This kind of war is just as wasteful of time and energy as is the ordinary variety, and, moreover, it is going on all the time. whereas the ordinary variety has intervals of cessation. It can only result in a reduction in the total product of labor and therefore in the average reward of labor.

"Moreover this kind of war almost invariably develops a habit of dishonesty and distrust, or at least of stretching the truth, which is one of the most vicious influences in our business life. I do not refer to clean, wholesome competition.

"It is the simplest possible axiom, when we stop to think—and few people ever do stop to think—that the only way, in the long run, for labor as a whole to get more wealth, is for it to create more wealth, and the only way to create more wealth is to increase the productivity of labor, or, to use a much abused word, to increase the efficiency of labor, which means co-operation on the one hand and the introduction of labor saving methods on the other.

"Just here is where the AMERICAN WELDING SOCIETY comes in, for one of its chief functions is to increase the application of welding, which is one of the greatest labor saving processes of the past few decades. Its predecessor, the Welding Committee of the Emergency Fleet Corporation, was animated in no inconsiderable degree with the spirit of co-operation, and it is the hope of the promoters of the Society that this spirit will be carried over.

"The field for further application of welding is enormous, but this further application is being delayed by lack of complete knowledge of the art of welding, and by the utterly confusing and, in many cases, diametrically opposing claims of competing interests. These hindrances ought to be removed and they can be removed by the successful conduct of research work, and by a cultivation of the co-operative spirit which will permit a frank, open discussion of the merits of the different processes, and a reasonable agreement as to those merits.

"If you were a prospective user of welding and were in doubt as to whether to use gas or electric welding or neither, do you think that your confidence in either process would be enhanced by having its exponents claim that it was the only safe and economical one? How much more confidence you would undoubtedly have, if you were told by the exponent of each, that in such and such fields the other was preferable.

"I am not setting forth impractical ideals, but rather the most common sense principles already found successful in many business fields, the application of which is bound to yield the best results for all concerned.

"Here then is our job, let us go to it with confidence, energy and enthusiasm, and let us remember that its successful completion will not only mean much to the welding industry, but that it will increase the average productivity of labor, and thus in some degree help to solve the greatest problem of this very critical period in the world's history."

The Welding Opportunity

The opportunity for increased use of welding divides itself into two fields. The first covers all ordinary work where the weld does not carry the main burden of the structure. This field only awaits the desires of the manufacturers for its development. Already it has been introduced into a great variety of industries, but it is obvious to the most casual observer that its use might be enormously extended with economy.

The second field includes the joints that become the strength members of a structure, and must, therefore, be subject to calculation. It is a noteworthy fact that welding is already used successfully for important work in this field, the cases being those in which the work cannot well be done otherwise. But to secure its general introduction in this class of work, much investigation is necessary. Through the bureau these investigations will be made in a manner to eliminate duplication and waste and to secure results at a minimum cost to the industry. The organization meeting of the society was held in New York City on March 28, 1919. The annual meetings for subsequent years being scheduled for the month of April.

The first active meeting was held on October 24, 1919, at the Engineering Societies Building, in New York City. At this meeting the following papers were presented:

"Gas Welding During the War," by H. Sidney Smith, Chief Engineer of the Prest-o-lite Co.

"A Theory of Metallic Arc Welding," by Ralph G. Hudson, Professor of Electrical Engineering at the Massachusetts Institute of Technology.

"Repairing a Lighthouse," by J. H. Deppeler, Chief Engineer, Thermit Department, Metal & Thermit Corporation.

The next meeting was held on December 12, 1919, at the Engineering Societies Building, New York City. The following papers were presented:

"Electric Resistance Welding," by P. T. Van Bibber.

"Gas Cutting," by Fred E. Rogers.

The foregoing was followed by a discussion of Professor Hudson's paper on "A Theory of Metallic Arc Welding," which had been presented at the preceding meeting.

It was then decided to hold a meeting outside of New York City, and Philadelphia was decided upon for this purpose. A meeting was held in the latter city on January 23, 1920, at Witherspoon Hall. At this meeting there were read:

"The First Electrically Welded Towing Target," by Commander H. G. Knox, U. S. N., and James W. Owens, Welding Aid, U. S. Navy Yard, Norfolk, Va.

"England's Progress in Electrically Welded Ship Construction," by H. M. Hobart, Consulting Engineer, General Electric Co.

"Sound Welds," by S. W. Miller, Rochester Welding Works.

"The Repair of the Stern Frame of the Army Transport 'Northern Pacific,'" by J. H. Deppeler, Chief Engineer, Thermit Department, Metal & Thermit Corporation.

The foregoing meeting filled Witherspoon Hall to capacity and attracted a great deal of attention and gave the first impetus to the formation of local sections. In fact, the organization of the Philadelphia Section was tentatively effected almost immediately after this meeting, and it was decided to hold the next meeting of the Society once more in Philadelphia. This was done on March 11th, a meeting again being held at Witherspoon Hall, and the following papers being presented:

"Gas Welding of Cast Iron," by C. K. Bryce, Engineering Department of the Oxweld Acetylene Co.

"Welding Cast Iron With the Electric Arc," by Robert E. Kinkead, of the Engineering Department of the Lincoln Electric Co.

"Thermit Welding of Cast Iron," by J. H. Deppeler, Chief Engineer, Thermit Department, Metal & Thermit Corporation.

The next meeting was held jointly with the New York Section of the American Society of Mechanical Engineers, on April 13, 1920, at the Engineering Societies Building, New York City, and the following papers were presented:

"Gas Welding," by Alfred S. Kinsey, Professor of Shop Practice, Stevens Institute of Technology.

"Elements of Arc Welding," by O. A. Kenyon, Engineer, Ray DeLillibridge, Inc.

"Thermit Welding," by J. H. Deppler, Chief Engineer, Thermit Department, Metal & Thermit Corporation.

The annual meeting of the Society was held on April 22, 1920, at the Engineering Societies Building, in New York City, and consisted of three sessions. The morning session was devoted to a business meeting. The afternoon session was given over to the American Bureau of Welding with a "Discussion of Welded Joints in Pressure Vessels." The evening session was devoted to the presentation of papers, as follows:

"Speed of Metal Arc Welding," by William Spraragen, of the Department of Electrical Engineering, of the University of Washington.

"Automatic Arc Welding Machines," by H. L. Unland, of the Power and Mining Engineering Department, of the General Electric Co., illustrated by moving pictures.

"Recent Development in Gas Cutting," by Stuart Plumley and F. J. Napolitan, of the Davis-Bournonville Co.

The formal organization meeting of the Philadelphia Section was held on May 27, 1920, and since then, sections have been formed in Chicago and in Pittsburgh. The formation of the Chicago Section took place on August 3, 1920, at meetings in the afternoon and evening in the rooms of the Western Society of Engineers, at Chicago, Ill., with an attendance of about seventy. The formation of the Pittsburgh Section took place on August 12, 1920, afternoon and evening meetings being held, and between sixty and seventy charter members being enrolled.

A preliminary meeting to consider the formation of a Metropolitan Section to take care of the local needs of members residing in New York City and vicinity was held on the afternoon of October 14, 1920, at the Engineering Societies Building, in New York City. A temporary organization was effected on that occasion, and the meeting was adjourned until the afternoon of October 25, 1920. On the latter occasion, a permanent organization was effected, officers being elected and by-laws adopted.

About 150 members of the Society residing in New York City and vicinity have been classified as members of the Metropolitan Section.

On the evening of October 25, 1920 (the same date on which the permanent organization of the Metropolitan Section was effected) a meeting of the Society was held at the Engineering Societies Building in New York City. The paper of the evening was "The Arc Welded Battle Towing Target No. 60" by Commander H. G. Knox, U. S. N., and James W. Owens, Welding Aid, U. S. Navy Yard, Norfolk, Va. This paper had been read once before under a slightly different title ("The First Electrically Welded Towing Target") at the meeting of this Society held at Witherspoon Hall in Philadelphia on January 23, 1920. On the present occasion, the paper was read by Mr. Owens, one of the co-authors who had also read it on the previous occasion. The paper was profusely illustrated by stereopticon and motion pictures, and was followed by an interesting discussion. It is to be published as a part of the proceedings in an early issue.

The formation of additional sections in other cities is being actively considered, particularly as regards Cleveland, Detroit and Atlanta.

It is hoped that before the December issue of the proceedings of this Society goes to press, news items from the various sections will be regularly available for prompt publication.

Aside from the ordinary activities of the Society in connection with meetings and papers and distribution of literature; the Society and the American Bureau of Welding are at present carrying on two activities which should be of great interest to the members.

The Storage Tank Welding Committee

Some time ago, at the request of the Standard Oil Company of New Jersey, a committee was appointed to consider the feasibility of welding storage tanks. This suggestion arose from the difficulty experienced in making riveted tanks tight for the lighter oils.

After conferences between this committee and the engineers of the Standard Oil Company, it was agreed that: On the one hand the committee should prepare the design and outline a procedure for the welding of a storage tank 40 feet in diameter; and, on the other hand, that the Standard Oil Company would pay for the construction of this tank. This demonstration should not only prove valuable in connection with the general problem of welding long joints, but should also indicate the feasibility of the application of welding to other types of steel structures.

The Boiler Code Conference Committee

This committee was appointed at the request of the Council of the American Society of Mechanical Engineers to confer with its Boiler Code Committee and to advise it in matters relating to the welding of unfired pressure vessels.

At the instigation of this committee, special welded specimen are being prepared at a dozen or more different plants, which will be tested at the Philadelphia Navy Yard. As soon as these tests have been made, sample pressure vessels will be made, and tested to destruction under the direction and inspection of the committee.

This work is all being done at the expense of interested manufacturers and users of welding apparatus, and practically without expense to the Society.

The spirit of co-operation shown by the interested industries promises ample support for other researches now under consideration.

WELDING SOCIETY AIDS SCHOOL

The Philadelphia Section, of the American Welding Society, is co-operating actively with the Drexel Evening School, Philadelphia, in planning and teaching the mathematics, chemistry and metallurgy of welding. In planning this course the school has taken account of the fact that

many of the men desiring thorough training in welding will not have had the necessary training in physics, mathematics, chemistry and metallury. For this reason the course has been planned to include these fundamental subjects. For those students who have had the required mathematics, chemistry and physics it is proposed to conduct advanced classes in metallury and welding should there be sufficient enrollment to warrant this. Because of the close co-operation with the Philadelphia Section of the American Welding Society the students in this course will be brought in close relationship with men who are intensely interested in the advancement of the art and science of welding.

PHILADELPHIA SECTION HOLDS RECEPTION

The chairman and Executive Committee of the American Welding Society, Philadelphia Section, extended a reception to present and prospective section members in the auditorium of the Engineers' Club of Philadelphia, Thursday evening, October 28th. The purpose was to bring together representatives of all the many interests already more or less involved in the application and use of welding and to have them briefly explain the possibilities of that art as viewed from the speaker's angle. Nearly forty speakers were listed on the program and their talks were limited to about three minutes.

METROPOLITAN SECTION OFFICERS

The Metropolitan Section of The American Welding Society was organized, October 25 in New York City. The following were elected officers of the Metropolitan Section.

Chairman—H. A. Currie, Assistant Electrical Engineer, New York Central Railroad.

1st Vice Chairman—E. E. La Schaum, Gen. Supt., Motor Equipment, American Railway Express Co.

2nd Vice Chairman—E. M. T. Ryder, Chief Engineer, Third Avenue Railway Company.

Treasurer—W. E. Gray, Jr., New York Sales Manager, Elyria Enameled Products Company.

Secretary—Howard Odiorne, Submarine Boat Corporation.

Executive Committee to Serve for Three (3) Years

H. G. Thompson, Transportation Engineering Corp'n.
Wm. R. Hulbert, Metal & Thermit Corporation.
E. J. Kingsbury, United Marine Contracting Corp'n.
J. C. O'Connell, Federal Shipbuilding Company.

To Serve for Two (2) Years

F. W. Smith, Chief Engineer, Oxweld Acetylene Co.
A. E. Gaynor, J. A. Roebling's Sons Co.
Chas. H. Haupt, Standard Oil Company.
Chas. P. Burr, G. M. Meurer Steel Barrel Company.

To Serve for One (1) Year

R. W. Baker, Lincoln Electric Company.
D. Ahldin, Commercial Acetylene Supply Co.
M. W. Kellogg, M. W. Kellogg Company.
Allen L. Price, Beckley Perforating Company.

Professor C. A. Adams gave a brief report of the work of the American Bureau of Welding, and outlined the tentative plans of the activities of the various sections of The American Welding Society for the next year. Applications for new sections at Cleveland, Baltimore, Detroit, Minneapolis, Atlanta and the Pacific Coast have been received.

Mr. J. W. Owens, Welding Aide at Norfolk Navy Yard, presented a paper entitled "The Arc Welded Battle Towing Target No. 60," by Commander H. G. Knox and J. W. Owens.

TO ORGANIZE WELDING INDUSTRY

An important decision involving the legality of patents on the process of spot welding was handed down recently by Judge J. M. Killets in the Federal Court in Detroit. Action was brought by the Thompson Spot Welder Co. against the Ford Motor Co., the plaintiff charging an infringement of the so-called Harmatta patent granted in 1912. The court held the Harmatta patent to be invalid and the bill of complaint of the Thmopson company was dismissed. The decision in favor of the defendant was based on a finding that F. F. McBerty, Warren, Ohio, anticipated Harmatta by a year or more in inventing and reducing to successful practice the process of electric spot welding and the upholding of some of the other claims set up in the answer of the defense. In a previous decision hand down in Boston in 1916, the Harmatta patent was held valid. It is expected the late decision will be appealed.

The defense in this case was conducted by the Welding Patents Investigating Committee which is composed of a large number of users of electric spot welding machines and of which H. C. Milligan, president Republic Stamping & Enameling Co., Canton, Ohio, is chairman. This committee will hold a meeting at the Hollenden Hotel, Cleveland, Nov. 9, to form a permanent organization to which all interested in the welding industry are invited. It is stated that the calling of this meeting has no connection with the Thompson case in Detroit. The object of the proposed organization will be to improve the methods in electric welding and to assist in patent work. Affiliated in the Welding Patents Investigating Committee, which has been in existence nearly two years, are nearly 500 men using 2,000 electric welding machines and it is expected that all these will become members of the new organization, the scope of which will be along broader lines than the work of the committee.—*The Iron Age.*

OXY-ACETYLENE IN THE BOILER SHOP

Few industries offer so many applications of welding in proportion to the number of operations involved in the manufacture, maintenance and ultimate disposition of a product as the boiler business. Welding is applied in various operations from the time the sheets are brought into the shop until the finished boiler is tested; it is applied at intervals throughout the life of the boiler for running repairs that can be best made by welding; and the worn out boiler is finally reduced to sizes for junk by use of the cutting blowpipe.

When the sheets are brought into the layer out they are often cut once to render them easier to handle. Such parts as dome saddles, washout holes and clean-out holes in the front ends of boilers are easily cut to precise measure by using a simple one-wheel attachment for radial work. The sheets leave the layer out for the shears and punches where mistakes are nearly always made. A hole punched in a wrong place is welded and the sheet saved; an edge or angle damaged by shears is reclaimed. Boiler iron is of high tensile strength, but flanges do crack despite the utmost care both in flanging and in fitting up or assembling. Here again vital defects are easily corrected with the welding blowpipe. In fitting up, the dome must be driven down into the saddle, the mud ring into the water space, and the old-fashioned heater bar, formerly used to help in fitting these heavy parts, is now being superseded to a great extent by the welding flame which, by applying a maximum of heat to a small area, permits the parts to fit easily and properly. This proper fit-up is absolutely necessary if rivets are to perform their service adequately, for the holes must be "Fair" and the flanges true. The staybolts are cut off to exact length for driving after they are inserted, and if, as it occasionally occurs, the staybolt hole is made too large in tapping, instead of using an oversize bolt the hole is welded and another of standard size drilled and tapped.

After the shell of a boiler is assembled the fire box is applied. Here again the welding blowpipe has proved its superiority over the old method of riveting. The sheets are welded together as well as the door hole.

In boiler repairs one of the most profitable applications for a welding blowpipe is the reclamation of fire flues and tubes. These are reclaimed very satisfactorily by cutting off the defective ends and welding on new short lengths.

Caulking edges in riveted fireboxes deteriorate so that either new sheets must be applied at considerable expense or the edges reclaimed by welding, which costs very little.

RECENT DEVELOPMENTS IN ELECTRO-PERCUSIVE WELDING*

By DOUGLAS F. MINER†

ELECTRO-PERCUSSIVE welding is a process which is primarily intended for manufacturing applications, where large quantities of duplicate parts are to be produced. One size of machine will handle a large variety of pieces over quite a range of size but it will be appreciated that more or less special holding fixtures must be designed to attach to a given machine. If only a small number of parts of each particular design and size is to be made, the necessary investment in fixtures may be excessive. Thus it will be apparent that repair work is not the most suitable field.

There is unlimited opportunity for development of automatic machines utilizing this process. Inasmuch as the time of welding is negligible, the only limitation of speed of production is speed of feeding and gripping the pieces. This permits a heretofore impossible output. Futhermore, unskilled labor can be used.

Suggestive of the type of applications determined to be suitable are the following:

Automobile Parts

Study of parts used in the construction of a prominent make of car, showed over 50 important parts where percussive welding would demonstrate a decided advantage over present methods.

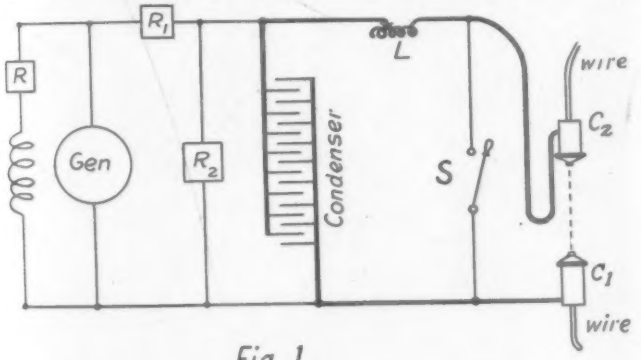


Fig. 1

Condenser Type Welder

Tools

Manufacturing costs of many types of tools using a special cutting portion attached to a cheaper grade shank would be reduced and better results obtained.

Hardware

There are countless items of hardware involving especially union of unlike metals or unequal sections which offer great possibilities.

The underlying principles utilized in percussive welding were discovered in 1905 by Mr. J. W. Chubb, of the Westinghouse Company. Following his original experiments Mr. Chubb developed machines for welding metals in wire form of rather small cross-section. With this equipment, very satisfactory welds were made between wires of various metals. Widely different physical properties of wires to be welded, offered no obstacle and perfectly ductile welds were made with platinum and lead, tungsten and aluminum, copper and aluminum.

The Apparatus

The apparatus consists essentially of a device for producing a percussive engagement of parts to be welded, practically simultaneous with a discharge of electrical energy. In the wire welders the energy is taken from an electrolytic condenser. Sets of aluminum plates immersed in an electrolyte of borax solution are charged by a direct current of very small value and discharged at the moment of weld. This discharge takes place at the parts to be joined and melts them with an explosive violence. At this moment the hammer forges the parts together into a perfect union. Fusing and union of the metals is finished in approximately .005 second. Fig. I shows a circuit diagram of this process.

Using an electrolytic condenser for source of fusing energy proved to have decided limitations because of limited amount of energy capable of being stored in a condenser of convenient size. Consequently, Mr. Chubb evolved a scheme for utilizing electrical energy stored in a magnetic field, thus substituting electro-magnetic energy for electro-static. Since about a year ago, we have been experimenting and developing apparatus

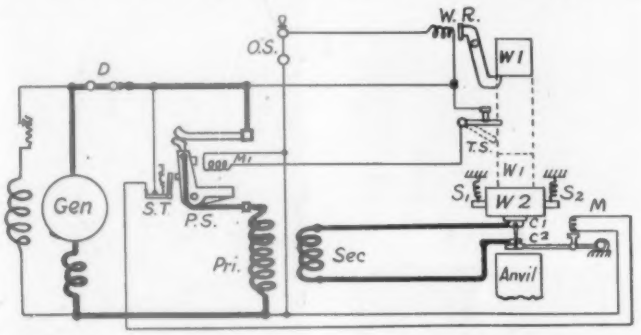


Fig. 2

Electromagnetic Type Welder

along this line and have been very successful in welds of the butt type up to a cross-sectional area equivalent to ½-inch diameter stock. Future work will extend this to much larger sections.

Description of Apparatus

To give a better understanding of the process, we may briefly describe the operation of an experimental outfit we have been using. Fig. 2 is a diagram of electrical circuits and Fig. 3 gives an idea of the appearance of apparatus.

Stated in simple terms, when any electrical circuit containing large inductance, such as a coil of many turns is interrupted, the stored energy of course tries to prevent the break and causes an arc to be drawn. An electric arc is a source of high intensity heat particularly well suited to welding operations. In an apparatus we have a reactance coil of two windings, one (primary) being connected momentarily to a source of direct current and the other (secondary) being connected to the pieces to be welded. By means of suitable tripping devices, the forging hammer causes the primary coil to be disconnected from the source of power, with the secondary closed. Transfer of energy of the collapsing magnetic field

*Presented at meeting of American Welding Society, Pittsburgh, Aug. 12, 1920.

†Research Engineer, Westinghouse Electric and Manufacturing Co.

to the secondary occurs and then a rapid small separation of the parts to be welded causes an intense arc to melt the surfaces. At the proper moment the hammer forges the pieces together. The complete operation occupies about 0.1 second of time, giving no time for oxidation or excessive heating. The time sequence of events shown on oscillogram taken during a weld between ⅜-inch copper and steel rod indicates a peak of current of 2600 amperes, an arc voltage of 30, maximum power 60 kw., energy, .00077 kw.-hr., and time .094 seconds.

Examples of Electro-Percussive Welding

Figure 4 shows some examples of electro-percussive welding and illustrates a few of the many types of joints possible. The joints are:—

1. Aluminum cable joint. Each wire of each end welded to a copper wire and the copper wires then joined by standard method of soldered joint.

2. Steel (cold rolled ½ in.) welded to ½ in. copper and pulled until chuck gouged metal—load applied, 41,000 lbs. per sq. in.

Figure 5.

Figure 6.

Figure 7.

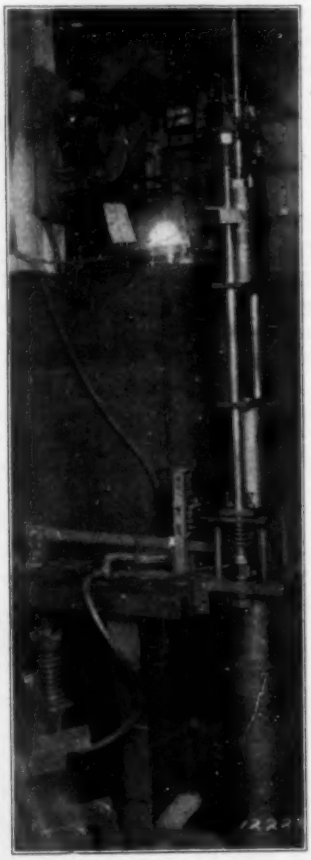


Figure 3. A Modern Type of Percussion Welder. At the Proper Moment the Hammer Forces the Pieces Together.

3. ½-in. steel welded to ½-in. copper. Broken by bending copper. Break is a copper break—no steel shows.

4. ½-in. steel welded to ½-in. copper. Failed in tension at load of 37,600 lb. per sq. in. Broke in copper near weld.

5. ½-in. steel welded to ½-in. copper showing character of break in copper.

6. ½-in. steel turned down to ⅜-in. and welded to ½-in. copper rod similarly turned down. 1 in. from weld another section of copper turned down to ⅜ in. and wrench applied to end. Copper bent without weld failing.

7. ⅞-in. steel-copper weld polished showing clean line of weld.

8. ⅜-in. steel-steel weld bent and hammered in all directions and all along reduced section until steel broke 1¼ in. from weld.

Microphotographs

Figs. 5, 6 and 7 show with an enlargement of 100 diameters, the character of a percussive weld between copper and cold rolled steel. In Fig. 5 the steel has been etched, but the copper left unetched. The reverse is the case in Fig. 6 while in Fig. 7 both metals were etched.

Passing from steel towards copper we notice that the first change from the structure of the virgin metal is an increase in pearlitic concentration (the dark spots). After this comes a laminated mass of pasty and melted steel which mingles with a layer of fused copper. Back of this is the unchanged coarse grain of the copper. Little or no amalgamation takes place and the two metals are sharply defined but interwoven by the force of compression. Interpenetrations are visible and examination at higher power shows small globules of steel in the area of fused copper. No cavities or oxide inclusions have been found which would destroy the strength of the joint if present.

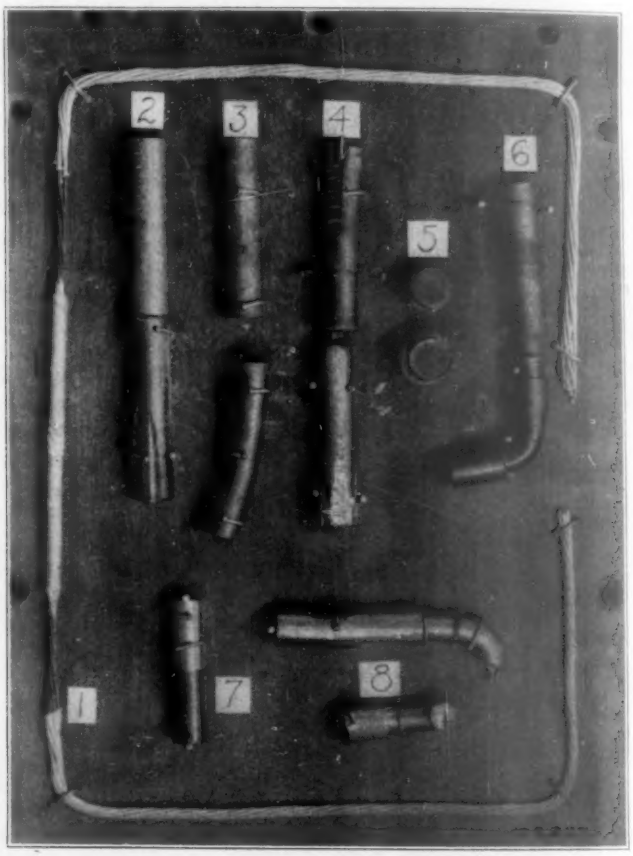


Figure 4. Showing Breaks in Aluminum, Copper to Steel and Steel to Steel Welds.

Advantages of Process

Some of the points of superiority which electro-percussive welding has are as follows:

(a) **Power Saved.** The power consumed at the weld by percussive welding is about one-sixth that required for same size stock by butt-welding, but this ratio could not be fully realized at the source of power due to the primary loss during establishment of field. Manipulation of circuits probably cannot be accomplished quickly enough to store exactly correct energy necessary, but at least ¼ power could be saved over butt-welding.

(b) **Time.** The operation is so rapid that the time of actual weld is negligible. Speed of production will, therefore, depend chiefly on the time of handling pieces. Saving along this line, of course, can be effected through automatic

(Continued on page 32.)

SHOULD WELDERS BE LICENSED"

Editor:

I have been reading *The Welding Engineer* ever since it was printed and consider it the treasure of the trade. I am a man about eight years at the welding trade and a good many young men come to me for information and explanations of welding, and I tell them what I can and then loan them my *Welding Engineer*. It gives the experience of a great many welders and experience is a good teacher. So now I want to discuss Mr. Leonard's letter in the May issue about craft welders. You cannot make it too plain for me, for in this town we have around 100 of what they call welders, but when it comes to the man who can weld anything that is weldable, I think about one-half dozen would be the number there are here.

Plasterers I call them. If some foreman went into some big factory and presented himself as a first class machinist, they would kick him out, but if the same man came along as a welding teacher, why he is as good as any of them. People seem to think they are all alike. I started in an all-around shop under a practical man or as nearly practical as there was at that time, eight years ago, where we welded all metal from flat wire the size of a straw up to any and all size castings and I studied expansion and contraction for about three years before I did much welding. What makes me sick is that some men who have helped in a welding shop a while will go and buy a welding outfit, then put themselves up against the experienced man for life. We are all alike so it seems to me that if we had a union or an organization that would class the welders or license them according to their ability in welding, then the trade would be better off. People would know just what class you were in or what you could do. I saw a welding school advertised last Fall that claimed to teach men the trade in six weeks so they could go out and do all or any kind of welding. That is just what hurts the trade. The man who has served three or five or more years in an all around shop has to compete with them at least until they are found out. Now Mr. Editor I might go on and tell you a lot of my experiences but my object in writing is to advocate an examination and prove their knowledge of the trade then license them accordingly. If a welder applies for a job and has something in the way of a certificate from a welding board of some kind, then the employer would know just what he could do.

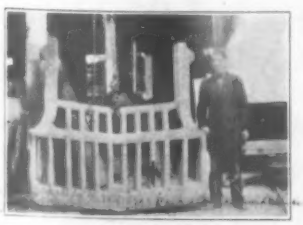
Yours for license,

L. L., Peoria.

CAST IRON BOILER REPAIRS

Editor:

These pictures show a cast iron boiler section that we recently repaired. It weighs 2,240 pounds, and is one of several similar jobs that we have handled successfully. In the rear of the photo you will note the oven we have for this kind of work. It is very convenient for preheating defective castings that foundries turn over to us for salvaging. A steel



Ready for the Oven.

The Break Repaired.

car, also shown in the photo, supports the casting and all we have to do is raise the door of the oven and pull the car and the casing out, cover with asbestos paper, weld the casting, push back the car, close the door and turn on the oil burners again. The entire operation takes about four hours on large pieces, and we save three to five hours' time.

W. J. Newell.

UNUSUAL WELDING JOB

The accompanying photo shows a welding job on a pneumatic riveter at the yards of the Schaw Batcher Shipbuilding Yards at South San Francisco.

The flaw which has been caused by sand-holes when the casting was made had existed for three years before it was discovered. The illustration shows the extent to which it was necessary to chip in order to make the weld. It was necessary to chip out on both sides of the riveter from the

The Chipping Took Seven Days.

point shown by the arrow at A to B on both sides of the riveter. The section chipped was about four inches in depth and was in the form of a V. The chipping job required one man using an air hammer seven days to complete.

It required the welder twelve days to make the electric weld, an average of 25 lbs. of welding rod being used in the job, making a total of 300 lbs. of welding rod used. The total cost of work and material was approximately $250. The riviter weighed about 14,000 lbs.

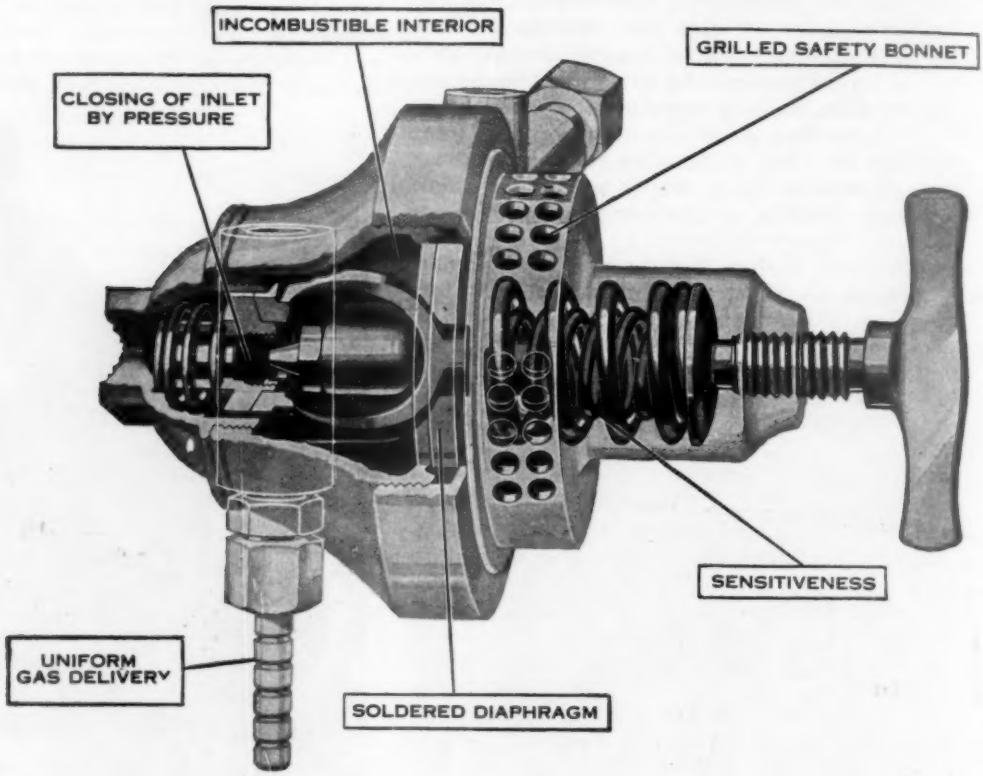
OXY-ACETYLENE FLAME SEPARATES LOCOMOTIVES

This is not a picture of an accident caused by someone being asleep at the switch. At a recent state fair in Minneapolis two locomotives were induced to stage a head-on col-

Carving Locomotives with the Torch.

lision for the amusement of the spectators. They made such a thorough job of it that they had to be cut apart with the oxy-acetylene flame.

Regulator *Facts*—Study Them



UNIFORM DELIVERY. The duty of a regulator is to deliver an even flow of gas at the desired pressure, irrespective of the cylinder pressure. Any fluctuation in delivery pressure changes the character of the flame at the torch, with ruinous results. All manufacturers claim steady delivery; few accomplish it. A comparison of principles will convince the purchaser that REGO regulators deliver the desired pressure without fluctuation. The gas flows from the cylinder through the inlet nozzle into the regulator without obstructions. This is important, as any moving part placed in the gas inlet and connected with the diaphragm must cause fluctuation due to the high pressure from the tank striking against it and obstructing the flow as the diaphragm moves.

SOLDERED DIAPHRAGM. The diaphragm is metal (phosphor bronze on the oxygen and German silver on the acetylene), soldered to the casting. This method of course eliminates any possibility of leakage at this point. Regulators which use metal diaphragms held to the casting by bolts usually employ a gasket to effect tightness. Rubber composition diaphragms are held to the body casting sometimes by bolts; usually by the spring housing.

The possibility of leakage on regulators using these designs is obvious. Soldered diaphragm regulators are more difficult to manufacture, requiring machine work to the thousandth part of an inch; whereas, other types do not require such care, as adjustments may be

THE BASTIAN BL
WEST AUSTIN AVENUE

made at the diaphragm. The elimination of leakage and the ruggedness of construction of the REGO soldered diaphragm regulator insure its standing up under the severe abuse to which regulators in the oxy-gas industry are subjected.

CLOSING OF INLET ACTUATED BY PRESSURE. The seat which closes the inlet nozzle is directly connected with the diaphragm and the movement of this seat against the nozzle is controlled by the diaphragm. This method of control is positive. The higher the pressure of gas against the diaphragm the harder the seat is forced against the nozzle. Should dirt, rust or scale get between the inlet and the seat, or should the seat become damaged, this pressure is certain to effectually shut off the gas entering the regulator from the cylinder. Compare this action with that of other types using a spring to close the seat against the nozzle and where the seat is not connected with the diaphragm The spring tension alone controls the closing of the inlet nozzle and should the space between the inlet nozzle and the seat become obstructed, there is nothing to prevent the full tank pressure entering the body of the regulator. An explosion may follow. The fact that there may be a safety device upon such a regulator does not obviate this hazard, as the sudden entrance of 1800 pounds pressure is too great for any ordinary safety to carry. REGO regulators eliminate this hazard by having the closing of the inlet actuated by pressure and not by springs.

INCOMBUSTIBLE INTERIOR. It is quite generally known that oil or fatty substances must never be used in connection with oxygen under pressure, as this combination may produce spontaneous combustion and an explosion would follow if the gas was confined. The REGO regulator uses nothing but metal except the seat, which is a special material not affected by oxygen. The wisdom of using diaphragms, gaskets and seats of an inflammable nature may be questioned. Aside from the possible hazard in connection with oxygen under pressure, a fire in the oxygen hose is led directly to the interior of the regulator if these inflammable materials are used; while in the REGO the fire would stop at the regulator, as there is nothing in the interior to burn.

SENSITIVENESS. Three springs are employed in the REGO regulator. Within the back cap is one which presses against the seat, and the tension of which is in turn transmitted to the diaphragm, the object being to keep the diaphragm in balance. The tension against the diaphragm is secured by two springs, one within the other. The low pressures are obtained by this inner, weaker spring and the heavy pressures by the outer larger one. It may readily be seen that a spring capable of fifty pounds tension is not suitable for a fine regulation and the REGO secures this fine regulation and higher pressures by employing two springs. The absolute alignment of the diaphragm, seat and springs essential to sensitive regulation is a detail of REGO manufacture carefully watched.

GRILLED SAFETY BONNET. In the bonnet or spring housing of the REGO is a series of perforations. Within is a knife edge. Should the seat of the regulator become entirely destroyed, or if for any reason excess pressure is delivered to the body of the regulator, the diaphragm is forced against this knife edge and cut, releasing the gas through the openings in the bonnet. No operator can ever be injured by the bonnet of a REGO being hurled off by bursting of the diaphragm.

SING COMPANY
A SALLE STREET CHICAGO.

ELECTRO- PERCUSSIVE WELDING

(Continued from page 28.)

or semi-automatic devices. A time study of a number of operations employing other methods of welding has shown that the saving in time by the use of percussive welding promises to be a large item which will allow a remarkable increase in production or reduction in labor charges.

(c) **Welds of Unequal Sections.** The extremely short duration of the fusing arc in the percussive process allows no chance for the heat to travel back into the metal. The necessary energy is concentrated in a very small amount of material, utilized where needed, and not dissipated in heating up the rest of the stock. Consequently, welds of unequal section are possible, such as a small rod to a heavy plate or a tube to a block. No preparation of the surfaces or previous treatment is necessary. Such welds, in order to be successful with other processes, necessitates either a preheating of the larger section or a modification of its shape, such as forming a projection of cross section equal to the smaller piece. This feature opens up a wide field of application allowing welding of some products formerly impossible, and greatly improving methods of manufacture on some products now employing other welding processes with special treatment.

(d) **Welds of Unlike Metals.** Just as the condenser type of welder produced welds with metals of widely different physical characteristics, the electro-magnetic type is also successful with such unions. Many of these were heretofore impossible. In many manufactured products it is desirable to join brass or copper parts uses for electrical circuits or for appearance to parts composed of steel used for its strength or cheapness. Percussive welding solves many of these problems without the use of screws, bolts or rivets.

(e) **Welds Without Change of Condition.** Percussive welding makes possible welds of parts in which the heating caused by other methods would either destroy the physical structure of the metal or would change its condition, such as drawing the temper. Welds can be made after any desired treatment without change of condition, because of the localized heat of the weld. Immediately after the weld is complete the piece can be handled and no appreciable warmth can be felt. Tool manufacturers are aided by this valuable feature.

(f) **Welds Uniform.** After the proper setting for a given weld is made, the character of the weld is always uniform and independent of the skill of the operator. The original settings made in accordance with a convenient table of values permit operation of the machine by unskilled labor without fear of poor results. With most other welding processes, the judgment of the operator must be relied upon to a large extent and chance of faulty work is large.

(g) **Finishing.** The percussive process produces a much smaller fin or flash than butt-welding, thereby decreasing cost of finishing. For many purposes no finishing operations are necessary. Recent results have indicated that percussive welding has many wonderful applications and will solve difficulties heretofore encountered, specially in non-ferrous and steel alloy welding. It is entirely possible also that the process may be extended to other types of joint than simple butt. Tests have indicated that applications in a wide variety of industries are available and it is hoped to increase the scope of the process in a large measure. A great deal of credit for development of the experimental apparatus should be given to Mr. C. F. Wagner.

FOR THE ATTENTION OF THE MANUFACTURER

A producer and wholesaler of oxygen in Denmark desires to secure an agency and purchase oxygen welding and cutting equipment for metals, all kinds of tools and apparatus for the ship building industry, iron and steel and automobiles. Reference. Address 34009, Bureau of Foreign and Domestic Commerce.

RAILROAD WELDING

Editor:

I was very much impressed by the report of the committee of the American Welding Society on Autogenous Welding. There is, beyond a doubt, much to be considered in that report before any action is taken. All who have been interested in welding for any length of time realize the scarcity of operators competent to perform this class of work. Unfortunately it is the general opinion throughout the mechanical trades that all there is to welding is the lighting of a torch, or the application of an electrode and smearing a little metal over a fracture. J. J. Tatum, of the B. & O. calls it "white washing" and a great many so called welds are receiving their full title when so styled.

There is not an industry or trade which requires more ingenuity experimentation and study on the part of the operator than that of the welding industry and yet in our railroad shops the man with the highest seniority, whether capable or not, is handed the torch with little or no instruction and expected to do first class work.

It seems in the report that the railroads are the ones most concerned and the ones having the most trouble. In my opinion that class of work above all others should receive the efficiency and skill of the best welders in the country and the sooner the railroad officials adopt this policy, the sooner they will rid themselves of the worry and the trouble they have experienced.

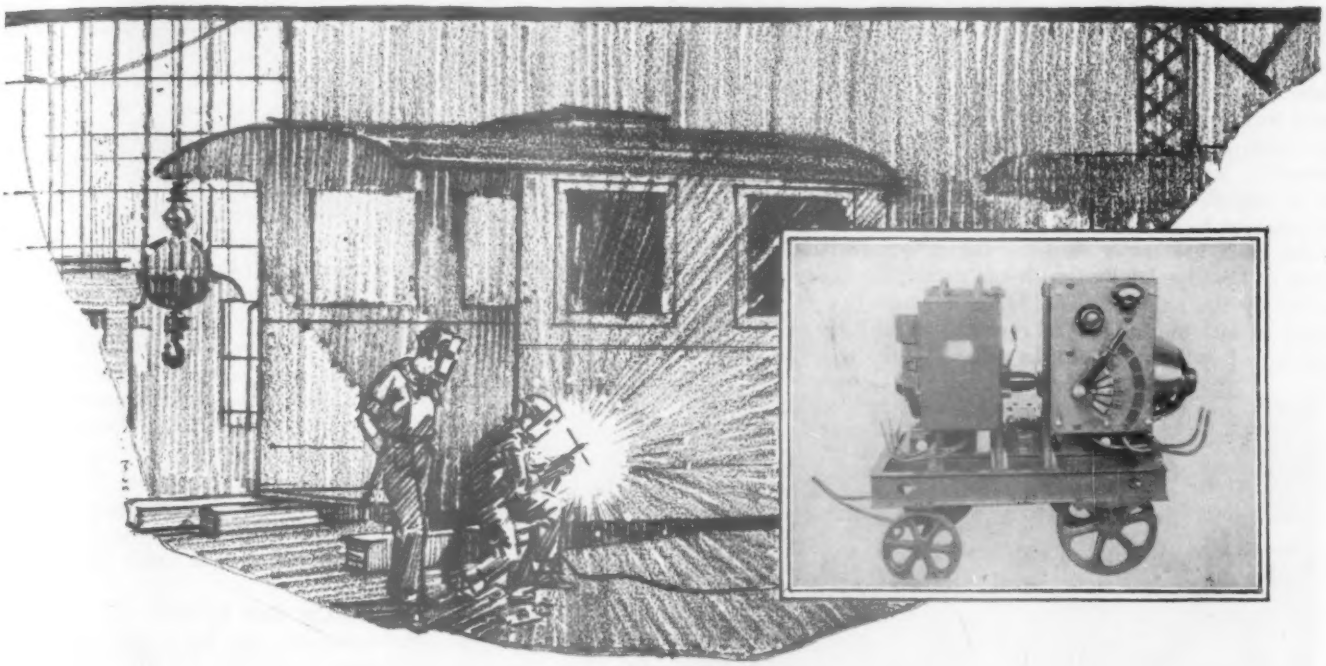
Then there is another failing of the railroad companies, and that is, the fact that the shop foremen and even the superintendents often do not know a good weld from a bad one. This is frequently a difficuult matter for an expert to determine if a poor job has been well camouflaged. I realize, however, that a man in that position has not the time to spend in perfecting his knowledge on every class of work with which he comes in contact. As a remedy for the situation I would heartily favor the suggestion of Professor A. S. Kinsey, of the Stevens Institute of Technology, that *welders should be licensed.* After a man has passed an examination given by a board of examiners appointed by the State Commissioners of Safety, he can probably be relied upon to do good work. It would be well to have it understood that if, after an investigation, it was found that a welder had neglected his duty, his license should be revoked.

Members of the welding trade will agree with me that there is not an industry or trade which has been condemned more severely than welding. Where there is smoke there must be some fire. Those who have condemned welding have had reason to do so. It is because of poor workmanship and of the inability of a foreman to judge. We know, too, that a good competent welder has been and is now a hard man to find. It is true that previous to this past year the education of welders has been sadly neglected, but now there is no excuse for one who is interested in welding to be anything but a first class welder for there are efficient schools for training in most large cities.

Autogenous welding reaches out into every phase of the mechanical world and often life itself depends upon the character of some welding. Yet we permit this work to be done by non-skilled and even careless operators while other trades such as plumbing and the electrical trade, which in my estimation are no more important than autogenous welding, require rigid examinations, rules, regulations and even the licensing of workmen. Under any consideration I cannot see why welders, working on pressure tanks and making welds in places where loss of life and destruction of property result from poor workmanship, should not be examined by commissioners of safety and be licensed if they prove capable. By such ruling we will soon build up the standards of the trade and prove its real value to the mechanical world.

Earl J. Thompson.

The secret of building specialized equipment is to build it so that it will do the specific thing for which it is designed



Whether It's a Big Job or a Little One—Weld It

From the cab plates of a huge locomotive to the tiny seam on a nickel plated bathroom fixture, electric arc welding has won for itself a predominant place in production. It has provided a means of doing the old job quicker, at less cost, with greater strength and longer life than the ordinary bolted or riveted joint.

There is a G-E arc welding set for almost every purpose, whether it requires a portable or stationary, single or multi-operator, or automatic equipment. No matter if the available current is direct or alternating—G-E sets are built to suit either one, or may be driven by an engine or from a line shaft.

Every possible phase of welding has been studied by G-E engineers. Their experience and their knowledge should be helpful to any manufacturer who contemplates the use of electric arc welding. The school for welders at Schenectady is free and open to men desirous of learning practical welding.

Add to these facts the proven advantages of electric arc welding as a production, repair and salvage measure, and then put your own problem up to G-E Specialists. If you can profitably use electric welding, they will show you how. If you can't they will tell you why.

Select the right equipment for the work—and a welder who knows his business

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43B-370

CUTTING CAST IRON WITH THE OXY-ACETYLENE TORCH†

By ALFRED S. KINSEY*

THE cutting of wrought iron and steel with the oxy-acetylene torch has been common practice during the past fifteen years, and it has generally been supposed that those metals represented the limit of the possibilities of the cutting torch. Within the past few months, however, much interest has been aroused by claims made for the cutting of cast iron with the oxy-acetylene torch, notwithstanding the fact that all authorities had declared such a thing to be impossible. Of course, many operators of the torch had tried in a superficial way to cut cast iron and had failed, chiefly because of lack of interest.

As there are many foundrymen who have not taken the time to become familiar with the principles used when metal is cut by the oxy-acetylene flame, it might be well before we proceed with our subject to consider what happens in the gas cutting of ordinary steel. In this work the torch is provided

Starting the Cut.

with a stream of low-pressure oxygen and another of low-pressure acetylene which combine to form what is known as the preheating flame. This is used to heat up the surface of the metal to be cut to a bright red, where the metal has a strong affinity for oxygen. Then an abundant supply of high-pressure oxygen from a third tube of the torch is directed upon the hot surface, and cutting follows due to the rapid *oxidation* of the metal. This actually is *burning* of the pure iron, or *ferrite* as it is called metallurgically. Hence the former oxy-acetylene cutters are now more frequently called *burners*.

As the burning of the iron proceeds an ash is formed. This is known as *iron oxide*, and it together with any other impurities of the metal are melted and run out as slag, of the slot being cut called the *kerf*.

There never has been any difficulty in cutting steel with the torch in this manner. Very little delay is experienced in setting fire to the ferrite, which usually has been attributed to the fact that the iron oxide melted and ran off at a *lower* temperature than that necessary to melt the ferrite. On the other hand, it has always been stated that the reason cast iron could not be cut was that its oxide had a *higher* melting temperature than its ferrite, and that the oxide insulated the ferrite from the heat of the flame so that ignition could not be obtained. Now that cast iron is being "cut" this oxide theory is refuted by some authorities, and it would seem well worth our time at least to briefly consider the whole subject.

What Has Been Accomplished

The author has from time to time as far back as three years ago tried to cut cast iron with the oxy-acetylene torch. Big castings requiring to be welded have had their edges beveled in this way. The crudeness of the work, however, always left a feeling that some day when time permitted experiments would be made to see if better work could not be accomplished. Within the past few months more careful efforts by the author and others* have borne interesting results. Varying thicknesses of cast iron up to *twelve inches* have been "cut," and as the path of the flame in some instances had to be well slanted the depth of cut was extended two or three inches beyond twelve. We believe a greater thickness than this can be "cut" with a torch tip properly designed for the work.

How To Cut Cast Iron

The torch need not be any different from the regular cutting torch for steel provided it will give a long carbonizing flame. In the experiments conducted by the author the standard cutting torch manufactured by the Air Reduction Co., New York, was used. The tip was the only special part necessary. It had to be made of a metal able to withstand unusually high temperatures and be designed so that its orifices would not be choked by the fire in the kerf as the cut ran

12-Inch Cut Under Way.

deep. Most of the actual cutting in the tests was done by trained cutters of the enginering service department of the above company.

The torch should be held so that the tip is tilted slightly

---

†*Paper read before a meeting of the American Foundryman's Association, Columbus, Ohio, October* 8, 1920.

---

*Professor of Shop Practice, Stevens Institute of Technology, Hoboken, N. J. Advisory Service Engineer, Air Reduction Co., New York.

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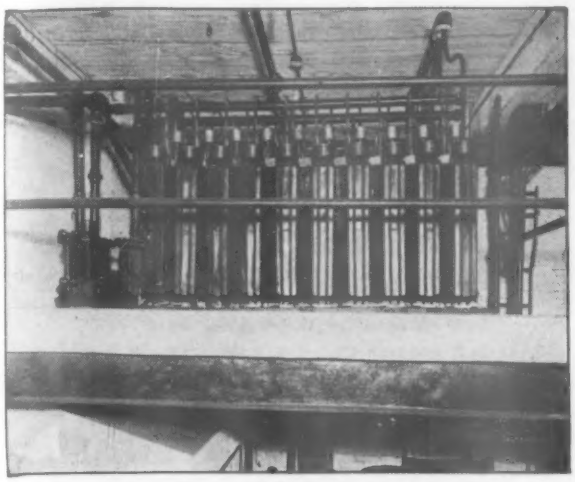
*See articles by F. J. Napolitan and Stuart Plumley, in the *Welding Engineer, July,* 1920.



Installation of 20 Levin Cells in Plant of American Mfg. Co.

Electrolabs Systems of Levin Cells

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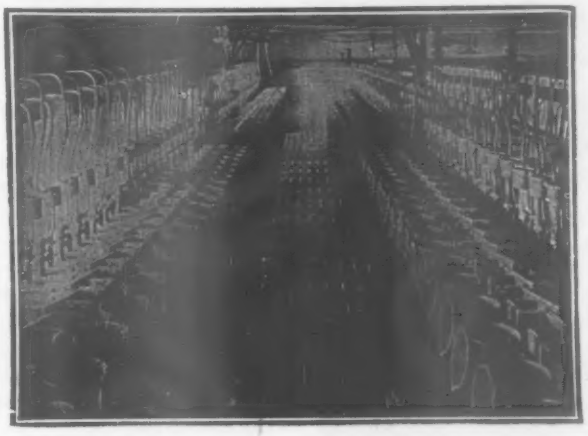

Levin Cells at General Electric Co., Erie, Pa. First installation in foreground, second installation in rear. A third installation of 100 recently purchased makes a total of 300 cells.

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backward for soft gray iron and more so for the harder irons. See Fig. 1. The cutter may easily determine the correct angle. The ignition spot on the iron must be bigger and hotter than for steel in order to insure a good start. The variableness in the hardness of the iron in most castings and also the blow holes will affect the cutting, sometimes "putting out the fire." A little spiral motion of the tip, however, usually will overcome the trouble. On the other hand, such a motion also will widen the kerf, thereby increasing the gas consumption in burning the larger amount of metal.

Cutting 14 Inches of Steel.

The most important part of the whole cutting operation is to maintain the proper gas pressures. These are much higher than for cutting steel as may be seen in the following table:

12-Inch Cast Iron Cut Completed.

Cast Iron Cutting Pressures

Size of Special Tip	Thickness of Metal Inches	Oxygen Pressure Pounds Square Inch	Acetylene Pressure Pounds Square Inch	
No. 1	1	50	15	Regulate the
No. 1	2	70	15	pressure so as
No. 1	4	85	15	to make a car-
No. 2	6	105	20	bonizing flame from
No. 2	8	115	20	1 to 2 inches long, in-
No. 2	10	150	25	creasing with thick-
No. 2	12	175	25	ness of metal.
No. 3	Over 12			

These pressures are necessarily appróximate as they will vary with the hardness of the casting.

The cutter should make certain that the oxygen supply is maintained at constant pressure. It is liable to drop due to rapid consumption, and thereby shorten the carbonizing jet and stop the cutting.

The casting will not need to be preheated other than that given by the preheating flame of the cutting torch. Some of our best cutting was done out of doors at a temperature of 60 degrees in a brisk wind.

The oxygen does not need to be preheated.

The cutter will find it necessary to protect his flesh, shoes and clothing from the excessive heat and flying sparks. Cutting cast iron is much hotter work than cutting steel.

So we may summarize these directions:

1. Use a special tip in a cutting torch which can maintain a long carbonizing flame.
2. Tilt torch slightly backward.
3. Make liberal size ignition spot.
4. Give slight spiral swing to tip if necessary.
5. Make carbonizing cutting flame 1 to 2 inches long.
6. Regulate gas pressures according to table and hardness of iron.
7. Keep the oxygen pressure constant.
8. The casting does not need to be preheated.
9. The oxygen does not need to be preheated.
10. Take extra precautions to protect the cutter from the unusual heat.

It will be noticed that these directions for the cutting of cast iron are not so very different from those which would be given for the cutting of steel, with the exception of the high gas pressures, the long carbonizing flame and the use of the special tip. This will be referred to again.

Effects of Oxy-Acetylene Cutting on Cast Iron

The cutting of cast iron by the gas torch produces a large amount of heat and quite some smoke (see Fig. 2) as compared with the clean cutting of steel (see Fig. 3).

There is a liberal deposit of slag and molten metal from the cast iron.

The kerf is three or four times wider than that for steel and its surfaces much rougher. See Fig. 4.

There usually are signs of molten metal on the surfaces, also some pitting, and the upper part of the kerf is charred black as if carbonized, not sooty.

The lower faces of the kerf usually have a heavy oxide scale over them, but a hammer blow will easily shatter and remove this.

While there of course must be some decarbonizing of the surface of the casting due to the burning, there is no important increase in the hardness of the surfaces of the kerf. It is apparent that very little of the graphite carbon changes to combined carbon, which probably is due to the protection afforded the surface by the oxide scale. It insulates the hot metal from the cold air, allows it to cool slowly which leaves the graphite carbon undisturbed. Suppose we try to make this a bit clearer to the beginner who has not familiarized himself with the elementary metallurgy of cast iron.

There are five standard grades of cast iron, No. 1 being the softest and No. 5 the hardest. No. 1 is of a dark gray color; No. 2, medium gray; No. 3, light gray; No. 4, mottled, and No. 5, white. So we hear of *gray* iron, meaning Nos. 1, 2 and 3, and of *white* iron, referring to Nos. 4 and 5. The best castings requiring to be machined are made of gray iron, while white iron is usually used for ordinary castings not needing machining. A good average gray iron is composed of about 93 per cent pure iron (ferrite), the remainder being chemical elements in about the following proportions:

	Per Cent
Carbon	3.50
Silicon	2.75
Manganese	.60

Phosphorus	.10
Sulphur	.05
	7.00

The carbon in cast iron is of two kinds, that which will not combine with ferrite, called *graphite carbon* and that which will combine with the ferrite and therefore known as *combined carbon*. The proportions of these carbons will vary according to the grade of iron, the approximate amounts for an average gray iron being graphite 3 per cent and combined .50 per cent. Graphite carbon softens and combined carbon hardens cast iron. If cast iron is made red hot, as in oxy-acetylene welding and cutting, and allowed to cool quickly the graphite carbon changes to combined carbon and the metal becomes too hard to file or machine. In welding this is prevented by covering the hot casting with asbestos or fire brick. In cutting cast iron the iron oxide left on the kerf faces undoubtedly keeps the casting from cooling too rapidly and preserves its softness.

Economy of Cast Iron Cutting

The cost of cutting cast iron with the oxy-acetylene torch is about five times as much as that for cutting steel.

Steel 12 inches thick can be cut with oxygen and acetylene at the rate of about 30 square inches per minute, costing say, 1.5 cents for labor, 10 cents for oxygen and 2 cents for acetylene, a total of 13.5 cents to cut 30 square inches per minute.

The 12-inch cast iron shown in the photographs was cut at the rate of 7 square inches per minute, costing 1.5 cents for labor, 13 cents for oxygen and 4 cents for acetylene, a total of 18.5 cents to cut 7 square inches per minute.

We may, therefore, calculate the following approximate figures on a basis of 100 square inches of metal cut:

To Cut by Hand Torch 100 Square Inches of Cast Iron and Steel With Oxygen and Acetylene.

	Consumption			Cost			
Material	Time Mins.	Oxygen Cu. Ft.	Acetylene Cu. Ft.	Time	Oxygen	Acetylene	Costs
Cast iron	15	123	21	$0.22	$1.84	$0.56	$2.62
Steel	3.5	25	2	.06	.37	.05	.48

Advantages to be Obtained From Cast Iron Cutting

While of course it may readily be understood that the cutting of cast iron with the oxy-acetylene torch will not have as wide an application to shop practice as the cutting of steel, it surely will be of valuable service in many instances as for example, the beveling of heavy castings preparatory to welding, reducing the size of bases and frames of machinery, removing big gates and risers and correcting castings in foundries, reducing big castings to scrap, for emergency work and in many other ways.

It will be recalled that the cutting may be accomplished with only the additional expense of a special tip for the regular cutting torch used for steel, provided the torch can maintain a long carbonizing flame as did those used in the above experiments.

Theory of the Cutting of Metals by Gas

The metallurgy of the cutting of steel and cast iron with the oxy-acetylene torch makes an interesting study, and while it will be necessary to use a few technical terms in this part of our paper, we shall assume that some of our readers will appreciate having the language kept as simple as possible.

It is a recognized fact that the smaller the total amount of chemical elements in an iron or steel the easier the metal may be cut. This leads to the assumption that where the oxygen from the torch can unite readily with the pure iron, called *ferrite*, rapid oxidation or "cutting" will occur. This accounts for the popular use of the cutting torch on steels containing carbon up to what is called the "true steel" condition, which has a carbon content of about .90 per cent. There the carbon goes into complete solution with the ferrite, after which cutting is more difficult. It will be remembered that the irons contain carbon in about the following proportions:

	From to	Per Cent C.
Wrough iron	.01	.10
Machinery steel	.10	.50
Tool steel	.50	1.50
Malleable iron	1.50	2.50
Cast iron	2.50	4.50

Therefore as the torch has been successfully used to cut metals containing as high as .90 per cent carbon, that includes wrought iron, machinery steel and tool steel.

The carbon in steel is usually in two forms, called *pearlite* and *cementite*. The pearlitic carbon assists cutting, while cementite carbon tends to interfere with it. Soft tool steel has its carbon chiefly in the pearlitic condition, but when the steel is made red hot and immersed in cold water its carbon changes to cementite and the tool becomes file hard. So we can understand why soft tool steel may readily be cut and why it is hardened it is so difficult to oxidize it. Going on up the scale of carbon content in the last table we come finally to cast iron with its average of say 3.50 per cent carbon, in the graphitic and combined state.

Now one may ask why could cast iron not be cut heretofore? One reason given is that the graphitic carbon distributes itself in *flaky* form throughout the ferrite making the whole mass infusible. Another explanation is that because of the high carbon content of cast iron the reaction between the ferrite and oxygen is slow and the stream of oxygen striking the hot iron tends to make the reaction still slower, resulting in a loss of heat and preventing cutting. We also have already mentioned the general belief that the iron oxide interfered.

Despite all of these obstacles cast iron is being "cut." So far as our own experiments are concerned we found that it was not necessary to heat the casting before starting to cut in order to change the nature of its carbon, as has been suggested by one writer, neither did we have to preheat the oxygen to accelerate the slow reaction between it and the ferrite due to its cooling effect. We found that while a pure reaction in cast iron cutting similar to that gotten in cutting stee still seems impracticable *it is possible to bring about a combined burning of the ferrite and melting of the oxide* so that a comparatively satisfactory cut can be made through cast iron. All of this we believe to be due principally to two conditions: (a) The unusually large supply of oxygen and acetylene used, and (b) the additional *fire* created in the kerf by the excess of acetylene from the torch, the carbon from which is in the finely divided particles so likely to produce a large volume of heat in the shortest time.

Conclusions

In the light of the many other fine accomplishments of the oxy-acetylene torch, we are just as sanguine for this new indication of its expanding application in the world of metals and would therefore emphasize the following:

1. That cast iron can be "cut" by the combined melting-oxidizing action of the oxy-acetylene torch.
2. That the cutting of cast iron, even though rather roughly done will be of fine advantage to shop practice in several ways, as already outlined.
3. That while the cost of cutting cast iron is high compared with the cutting of steel, that should not prevent the proper use of the new method. There will be many instances of where the torch can be successfully used on a job which could not be taken to a machine for repairs.
4. That any experienced operator of the cutting torch on steel can quickly learn to cut cast iron.
5. That a special cutting torch is unnecessary provided one is used which operates with excess of acetylene. An inexpensive tip is the only special part.

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A Field Worth Watching.

IN twenty years the art of Railway Signaling has been developed to a high degree of efficiency. During this period of progress, however, absolutely no progress has been made so far as steam railroads are concerned, in the method of connecting rails with wires to crry the necessary track circuit. In the ends of abutting rails two $\frac{3}{32}$" holes are drilled and wire is inserted, being held in place by channel pins. This method has always resulted in maintenance trouble, false, danger signals and train delays. Signal maintainers occupy much of their time in locating broken bond wires.

In the September issue of *The Welding Engineer* Mr. Kolb tells of some successful experiments with a welded rail bond and it seems safe to predict that such a bond will be adopted by the Signal Engineers in the near future. In this event the welding equipment needed by the railroads will amount to considerable.

How Not to Do It.

AN example of how not to do it is often not amiss. The other night our automobile lights didn't seem to function as they should, and when we investigated we found that the advertising manager of some dinky little repair shop had caused to be pasted on our lights a little round label directing us to proceed to said shop for welding repairs. By the time we finished scraping the pesky things off, wondering meanwhile why the impudent lobster didn't puncture our gas tank to make sure that we'd need repairs, we had formed a lasting opinion of that man and his shop. An advertising campaign can be clever and original and even effective, without producing orders. Think it over.

Back to Earth

ONE of the provisions of the recent agreement signed by officials of the Chicago Building Trades Council was that "any man who loafs on the job can be fired by the contractor without fear of having a strike the next hour." And a contemporary reports that one Springfield manufacturer reduced to a 40 per cent normal force and is getting 200 per cent output. Similar instances are numerous everywhere. Has labor been engaged in some profiteering on its own hook? It looks that way. It looks also as if we were getting back to earth. Profiteering isn't good business, but "people who live in glass houses should undress in the dark."

He Hits the Nail on the Head

AS reported in *The Welding Engineer* for October, discussion of a simple preheating problem by the American Welding Society, Chicago Section, at its October meeting was full of emphatic arguments for and against preheating. A good common-sense comment was received from a man with large experience in welding, who was not able to attend the meeting. The gist of his remarks was, "I would do everything possible to make a perfect weld, then if anything happened to it I would know that it was not my fault but that the job simply could not be done better."

Pressure vs. Prudence.

WE still have with us the man who says "It can't be done," and "It ain't so." Here is a letter from him to a manufacturer of a modern type of acetylene generator:

"I had a weld last week that I had to turn down where I could have received $75.00 or more for the job but I had to have a working pressure of 50 pounds of acetylene, and the generator would not handle it, so I rented a Tank and done the job. I am here to advise the boys that they have another invention to make if they want their customers and users of the generator to get success and really get down to welding. I am not new at this game I have been a welder

Prest-O-Lite
as a Production Factor

NOT so long ago the oxy-acetylene process of welding and cutting was almost entirely confined to repair and wrecking operations.

However, of recent years its remarkable ability to reduce manufacturing costs has made the oxy-acetylene process one of the foremost productive factors in metal working plants.

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DISSOLVED ACETYLENE

the Universal Gas with the Universal Service

is especially adapted for welding and cutting of this nature. Its uniform character and Nation-Wide Service assure an unvarying and unfailing supply of dissolved acetylene for the manufacturer who uses only one or a thousand cylinders a day.

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P. W. 520

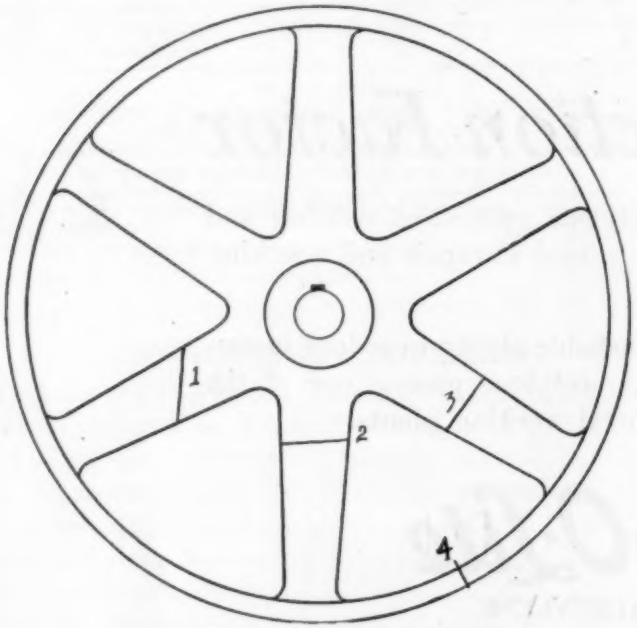
and a licensed welder for over two years doing real work and real welding. I do not consider this play toy of a generator a machine any longer, it is alright if a man don't know no better. Even though that generator was O. K. it was not worth over $25.00 as I am not new at this game I have welded a long time and you people that never had a burning torch in your hand try to give advice."

Here is a man who needs a copy of The Welding Encyclopedia. The rules laid down by the insurance underwriters will tell him some things he wants to know. Here's hoping he gets his copy before he blows himself into "kingdom come," monkeying with a homemade acetylene generator working at a few hundred pounds pressure.

Classified ads

WELDING WITHOUT PREHEATING

An article by Mr. Bernard in the January, 1920, issue of *The Welding Engineer* interested me very much. Regarding cast iron welding, I firmly believe that more of these jobs are spoiled by preheating than in any other way. Welders should stop and consider whether or not a job can be done without preheating before going ahead with the work. Eighty-five jobs out of 100 will be spoiled by the preheating fire. I, like Mr. Bernard, know that to be a fact. If you will apply the proper amount of heat and at the proper place you will avoid all blow-holes and hard spots. Hard spots are in all cases caused by improper heat or the improper use of it, or both. Don't understand me to condemn preheating fires in all cases, for in some cases they are absolutely necessary. Let us take for example a cast iron wheel with four, five, or six spokes in it; we have three spokes broken and the rim not broken. One way to handle this job is to put the wheel in a fire and preheat it. You might get by with it, but even if you made your weld hold I am sure you would find the wheel warped. In my eleven years experience I have had a great deal of this kind of work, and have tried many ways to do it. The way which has been the most successful is as follows:



Four Welds Made without Preheating.

Cut the rim with a hack saw at No. 4;
Weld No. 1;
Weld No. 2;
Weld No. 3;
Let the wheel cool slowly;
When cool weld No. 4;
Cover wheel with asbestos paper and allow to cool slowly.

Take for another example cast aluminum with blow-holes or sand holes from molding. Suppose the casting to be hollow or pan shaped, six inches deep, and six inches or more wide, with no cross bars inside. Light your torch and flash over the casting enough to take off the chill, and weld the hole or crack. After welding, flash your torch over the casting as before for just a short time until your welded matter is settled. Wrap in asbestos paper and allow to cool slowly.

If the piece is an aluminum crank case with cracks in the bottom or sides, and contains cross bars and bearings, it is necessary to preheat some. Some parts of the casting are half an inch thick, some three quarters of an inch, and some parts even thicker. It is impossible to tell more about how to handle such preheating jobs than that they must be done in such a way as to heat the casting evenly, and it must be cooled evenly. By all means do not hurry such jobs.

When you have a crank case with a lug of some kind broken I don't think it is necessary to preheat; in fact many times such jobs can be accomplished right on the car.

Some time ago I had the job of patching an aluminum kettle in a job shop. This kettle was made of sheet aluminum. It was sixty-two inches in diameter across the top, and forty-two inches deep, with the bottom in the shape of a wash bowl. I found it necessary to cut out some of this bottom and fuse a patch of sheet aluminum to replace it. I was advised by several of my fellow workmen to preheat this kettle. They told me that it was out of all reason to undertake such a job without preheating. A one hundred per cent weld was accomplished without preheating, however, and I feel sure that if I had preheated I would have had a lot of trouble with cracks.

The young welder should not be deceived by the easy manner in which the expert executes his weld. It takes experience to do this work and be successful.

J. T. Gibbs.

ARTHUR E. HAUCK

Arthur E. Hauck, president of the Hauck Mfg. Company, manufacturers of oil burning appliances, kerosene torches, furnaces, forges, Brooklyn, N. Y.; died at his Flatbush home, Brooklyn, N. Y., October 30, aged 41.

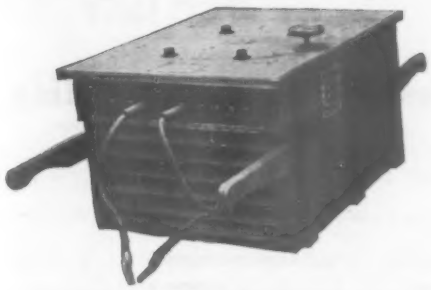
He began his career by learning coppersmithing in Germany. After learning his trade, he left his mother country to follow his trade in the navy and ship yards of Belgium, France, and later in England. He arrived in this country when 20 years of age. He had only enough funds left when arriving in Philadelphia to pay for his first night's lodging, but the next day he obtained employment at the Philadelphia Navy yards.

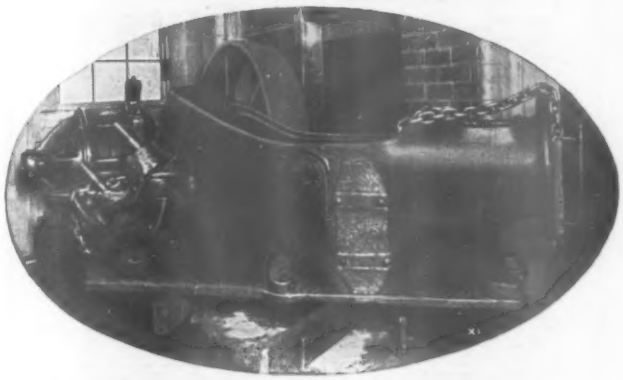
After working for 3 years in the Navy coppersmithing shops in Philadelphia, Norfolk, Baltimore and Brooklyn, he started in the Oil Burner business in 1902 with a small shop in Brooklyn. His pioneer work was the basis for a great bulk of industrial oil burning today. His tireless industry continued with the development of the Oil Burner business which carried his name. Its consistent growth and development include over a score of important basic patents in burning oil, kerosene, etc., as well as numerous minor inventions and improvements which deal with applications of burning oil for a great many uses.

One of his principal patents is the method of vaporizing kerosene in a torch with proportioned heat resisting nozzle, the form of vaporization reducing carbonization. Another basic patent is the Hauck method of atomization through proportioned pipes and openings and with composition nozzle, and what is termed the internal combustion.

From its inception Mr. Hauck brought into his business men whom he wished to share his success. In this way he looked ahead and built his business on a firm foundation and insured a continuation of its growth along established policies.

Take the Welder to the Work





The compressor bed shown above was "Alternarc" welded between shifts, preventing a shut-down. The Union Hardware Co., of Torrington, Conn., where this photo was taken has been using an "Alternarc" for some time, to them it is indispensable.

The PORTABLE "ALTERNARC" CUTTING AND WELDING MACHINE is the 20th Century preventative of costly shut-downs.

Take it to the job, plug in on the switchboard and the "Alternarc" is ready to give a perfect weld—absolutely free "of cold shots."
The "Alternarc" is equally efficient on any kind of welding and our 600 ampere equipment is unsurpassed for economical rivet cutting.

Our engineering force is ready to assist you on your welding problems. Send us samples, we will weld and return them with cost data.

Write for descriptive literature—Series D.

Electric Arc Cutting and Welding Co.
152-158 Jelliff Ave. Newark, N. J.

BRANCHES:
Pittsburgh Philadelphia Chicago St. Louis
Detroit Cleveland Cincinnati Montreal

Fyber-Weld GOGGLES for Welders

Fitted with "Essentialite" Lenses

Frame is made entirely of vulcanized fibre, and in addition to being light in weight is a non-conductor of heat and electricity, is non-inflammable and infusible, is not affected by moisture or perspiration and is easily sterilized and kept sanitary. Has flexible leather center, ventilated side pieces and adjustable elastic headband.

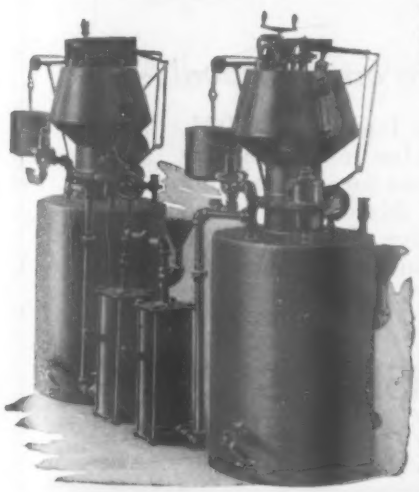
Prices as follows:

No. 510, fitted Essentialite lenses, No. 4 shade, for cutting and cover glasses	$3.00 pair
No. 510, fitted Essentialite lenses, No. 6 shade, for welding and cover glasses	$3.00 pair
No. 510, fitted with amber, smoked green or deep blue, cesco blue and cover glasses	$2.50 pair
Extra cover glasses in clear or amber tint	.20 pair

"ESSENTIALITE" LENSES

To those of our patrons who are not thoroughly conversant with the real qualities and benefits of "Essentialite" lenses, we take pleasure in furnishing the following information. In placing the "Essentialite" before the trade, we have, after years of experimenting and research, succeeded in discovering the means of protecting the delicate organism of sight against the destructive Ultra Violet rays. We have demonstrated conclusively that with these lenses we vanquish the so-called "fatigue-weariness" and headaches caused by Ultra Violet and Infra Red rays.

Manufactured By **CHICAGO EYE-SHIELD CO., 2300 Warren Ave., Chicago, Ill.**



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Our New England States Representative,
R. I. WELDING CO., Providence, R. I.

Hamilton, Ohio

The Welding Encyclopedia

Will

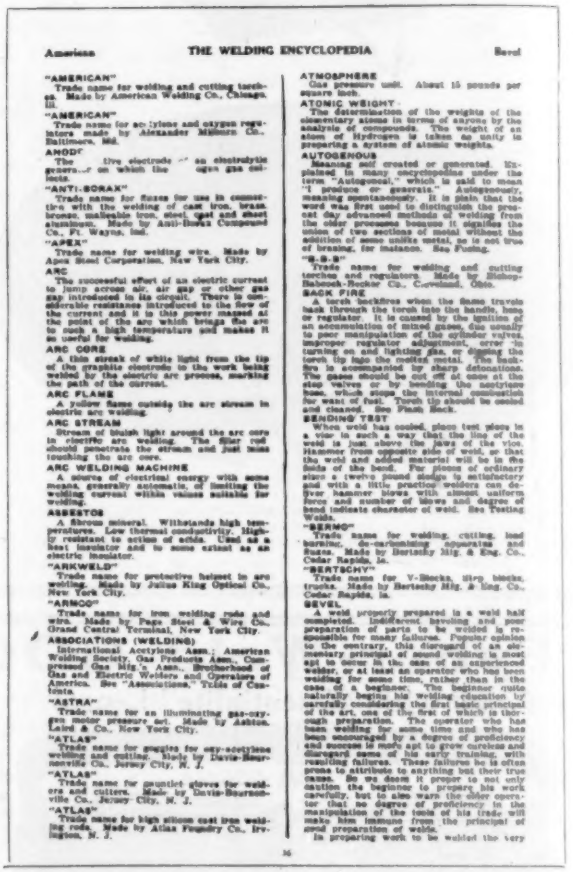
Take the Guesswork Out of Welding

THIS book covers every phase of the art of Autogenous Welding as no other publication or group of publications has ever covered it. The Dictionary section of the text alone contains more information of value to welders than any book we know of. All the words and terms used in welding are carefully defined and illustrated. This section includes the explanation of all trade names that have been given to things the welder uses, arranged alphabetically for easy reference, and supplying the makers' names and addresses. All this information is impartial, the idea is to present information that will enable the welder to understand his work better, no matter what the process is.

In the Instruction section will be found the approved methods of welding all standard metals by the various processes, such as Oxy-Acetylene, Electric Arc and Thermit. A carefully prepared group of tables and charts give the welder here a big store of useful "dope," right at his finger-tips all the time.

The compilation of government, insurance and railroad regulations and codes for welding covers the installation of equipment and all welding operations.

Just such a book as this has been needed by the welding craft for several years. In order to make it a complete and practical reference work in every respect the leading manufacturers of welding apparatus and supplies have arranged to include condensed catalogs of their products in the advertising section. Welders will value the advertising section as a complete buyers' index.



America THE WELDING ENCYCLOPEDIA Bevel

"AMERICAN"
Trade name for welding and cutting torches made by American Welding Co., Chicago, Ill.

"AMERICAN"
Trade name for acetylene and oxygen regulators made by Alexander Milburn Co., Baltimore, Md.

ANOD
The live electrode or an electrolytic process on which the oxygen gas collects.

"ANTI-BORAX"
Trade name for fluxes for use in connection with the welding of cast iron, brass, bronze, malleable iron, steel, cast and sheet aluminum. Made by Anti-Borax Compound Co., Ft. Wayne, Ind.

"APEX"
Trade name for welding wire. Made by Apex Steel Corporation, New York City.

ARC
The successful effort of an electric current to jump across air, air gap or other gas gap introduced in its circuit. There is considerable resistance introduced to the flow of the current and it is this power created at the point of the arc which brings the arc to such a high temperature and makes it so useful for welding.

ARC CORE
A thin streak of white light from the tip of the graphite electrode to the work being welded by the electric arc process, marking the path of the current.

ARC FLAME
A yellow flame outside the arc stream in electric arc welding.

ARC STREAM
Stream of bluish light around the arc core in electric arc welding. The filler rod should penetrate the stream and just miss touching the arc core.

ARC WELDING MACHINE
A source of electrical energy with some means, generally automatic, of limiting the welding current within values suitable for welding.

ASBESTOS
A fibrous mineral. Withstands high temperatures. Low thermal conductivity. Highly resistant to action of acids. Used as a heat insulator and to some extent as an electric insulator.

"ARKWELD"
Trade name for protective helmet in arc welding. Made by Julius King Optical Co., New York City.

"ARMCO"
Trade name for iron welding rods and wire. Made by Page Steel & Wire Co., Grand Central Terminal, New York City.

ASSOCIATIONS (WELDING)
International Acetylene Assn.; American Welding Society, Gas Products Assn., Compressed Gas Mfg's Assn., Brotherhood of Gas and Electric Welders and Operators of America. See "Associations," Table of Contents.

"ASTRA"
Trade name for an illuminating gas-oxygen motor pressure set. Made by Ashton, Laird & Co., New York City.

"ATLAS"
Trade name for goggles for oxy-acetylene welding and cutting. Made by Davis-Bournonville Co., Jersey City, N. J.

"ATLAS"
Trade name for gauntlet gloves for welders and cutters. Made by Davis-Bournonville Co., Jersey City, N. J.

"ATLAS"
Trade name for high silicon cast iron welding rods. Made by Atlas Foundry Co., Irvington, N. J.

ATMOSPHERE
Gas pressure unit. About 15 pounds per square inch.

ATOMIC WEIGHT
The determination of the weights of the elementary atoms in terms of oxygen by the analysis of compounds. The weight of an atom of Hydrogen is taken as unity in preparing a system of atomic weights.

AUTOGENOUS
Meaning self created or generated. Explained in many encyclopedias under the term "Autogenol," which is said to mean "I produce or generate." Autogenously, meaning spontaneously. It is plain that the word was first used to distinguish the present day advanced methods of welding from the older processes because it signifies the union of two sections of metal without the addition of some unlike metal, as is not true of brazing, for instance. See Fusing.

"A.B.S."
Trade name for welding and cutting torches and regulators. Made by Bishop-Babcock-Becker Co., Cleveland, Ohio.

BACK FIRE
A burn backfires when the flame travels back through the torch into the handle, hose or regulator. It is caused by the ignition of an accumulation of mixed gases, due usually to poor manipulation of the cylinder valves, improper regulator adjustment, error in turning on and lighting gas, or dipping the torch tip into the molten metal. The backfire is accompanied by sharp detonations. The gases should be cut off at once at the cylinder valves or by breaking the acetylene hose, which stops the internal combustion for want of fuel. Torch tip should be cooled and cleaned. See Flash Back.

BENDING TEST
When weld has cooled, place test piece in a vise in such a way that the line of the weld is just above the jaws of the vise. Hammer from opposite side of weld, so that the weld and added material will be in the fields of the bend. For pieces of ordinary size a twelve pound sledge is satisfactory and with a little practice welders can deliver hammer blows with almost uniform force and number of blows and degree of bend indicate character of weld. See Testing Welds.

"BERNO"
Trade name for welding, cutting, heading, de-carbonizing apparatus and fluxes. Made by Berlesky Mfg. & Eng. Co., Cedar Rapids, Ia.

"BERTSCHY"
Trade name for V-Blocks, step blocks, trucks. Made by Bertesky Mfg. & Eng. Co., Cedar Rapids, Ia.

BEVEL
A weld properly prepared is a weld half completed. Indifferent beveling and poor preparation of parts to be welded is responsible for many failures. Popular opinion to the contrary, this disregard of an elementary principal of sound welding is most apt to occur in the case of an experienced welder, or at least an operator who has been welding for some time, rather than in the case of a beginner. The beginner quite naturally begins his welding education by carefully considering the first basic principal of the art, one of the first of which is thorough preparation. The operator who has been welding for some time and who has been encouraged by a degree of proficiency and success is more apt to grow careless and disregard some of his early training, with resulting failures. These failures he is often prone to attribute to anything but their true cause. So we deem it proper to not only caution the beginner to prepare his work carefully, but to also warn the older operator that no degree of proficiency in the manipulation of the tools of his trade will make him immune from the principal of good preparation of welds.

In preparing work to be welded the very

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THIS is a specimen page of The Welding Encyclopedia made up to show the variety of subjects treated and the method of treatment. This sample page is one-fourth actual size. The definitions given are incomplete and subject to revision before publication.

How to get a copy of The Welding Encyclopedia on Approval:—

THE Welding Encyclopedia will be ready for distribution January 1, 1921. We expect that the first edition of 5,000 copies will not last long. Readers of The Welding Engineer can get one of the first copies off the press by mailing the coupon at the bottom of the opposite page. Order with this coupon and a copy will be sent to you on approval. You keep the book five days and if it doesn't prove to be worth the purchase price send it back and we'll cancel the charge.

PUBLISHED BY

THE WELDING ENGINEER PUBLISHING CO.

608 S. Dearborn Street CHICAGO, ILL.

The Welding Encyclopedia

Will Tell You:—

The principles of all the various welding processes;

The applications of all the various welding processes;

How to make and how to test welds;

The definitions of hundreds of words and terms used in current literature on welding;

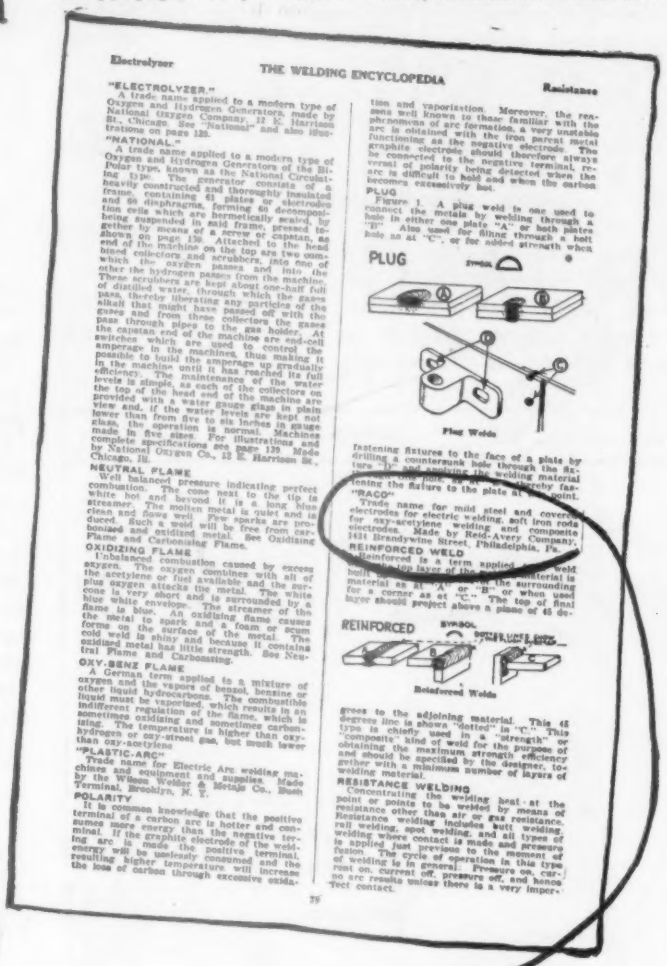
The characteristics of all metals that can be welded;

Where to go for all equipment and accessories used in the welding shop;

The answers to hundreds of questions that are not answered elsewhere.

Finding information in The Welding Encyclopedia is as easy as looking up "Cat" in the dictionary. All words, terms and trade names used by the welding craft are arranged alphabetically. Special articles on methods, rules, etc., are grouped and conveniently cross-indexed. The sample page shown here is ¼ actual size. It will illustrate this easy reference idea, and show the style of the type page. With this book in his shop the welder can instantly lay his finger upon any desired bit of welding information.

This is a composite page, ¼ actual size, made up to show the style of type and type-page, variety of subjects treated, and method of treatment.


Electrolyzer THE WELDING ENCYCLOPEDIA Resistance

"ELECTROLYZER."
A trade name applied to a modern type of Oxygen and Hydrogen Generators, made by National Oxygen Company, 12 E. Harrison St., Chicago. See "National" and also illustrations on page 129.

"NATIONAL."
A trade name applied to a modern type of Oxygen and Hydrogen Generators of the Bipolar type, known as the National Circulating type. The generator consists of a heavily constructed and thoroughly insulated frame, containing 61 plates or electrodes and 60 diaphragms, forming 60 decomposition cells which are hermetically sealed, by being suspended in said frame, pressed together by means of a screw or capstan, as shown on page 128. Attached to the head end of the machine on the top are two combined collectors and scrubbers, into one of which the oxygen passes and into the other the hydrogen passes from the machine. These scrubbers are kept about one-half full of distilled water, through which the gases pass, thereby liberating any particles of the alkali that might have passed off with the gases and from these collectors the gases pass through pipes to the gas holder. At the capstan end of the machine are end-cell switches which are used to control the amperage in the machines, thus making it possible to build the amperage up gradually in the machine until it has reached its full efficiency. The maintenance of the water levels is simple, as each of the collectors on the top of the head end of the machine are provided with a water gauge glass in plain view and, if the water levels are kept not lower than from five to six inches in gauge glass, the operation is normal. Machines made in five sizes. For illustrations and complete specifications see page 129. Made by National Oxygen Co., 12 E. Harrison St., Chicago, Ill.

NEUTRAL FLAME
Well balanced pressure indicating perfect combustion. The cone next to the tip is white hot and beyond it is a long blue streamer. The molten metal is quiet and is clean and flows well. Few sparks are produced. Such a weld will be free from carbonized and oxidized metal. See Oxidizing Flame and Carbonizing Flame.

OXIDIZING FLAME
Unbalanced combustion caused by excess oxygen. The oxygen combines with all of the acetylene or fuel available and the surplus oxygen attacks the metal. The white cone is very short and is surrounded by a blue white envelope. The streamer of the flame is blue. An oxidizing flame causes the metal to spark and a foam or scum forms on the surface of the metal. The cold weld is shiny and because it contains oxidized metal has little strength. See Neutral Flame and Carbonizing.

OXY-BENZ FLAME
A German term applied to a mixture of oxygen and the vapors of benzol, benzine or other liquid hydrocarbons. The combustible liquid must be vaporized, which results in an indifferent regulation of the flame, which is sometimes oxidizing and sometimes carbonizing. The temperature is higher than oxy-hydrogen or oxy-street gas, but much lower than oxy-acetylene

"PLASTIC-ARC"
Trade name for Electric Arc welding machines and equipment and supplies. Made by the Wilson Welder & Metals Co., Bush Terminal, Brooklyn, N. Y.

POLARITY
It is common knowledge that the positive terminal of a carbon arc is hotter and consumes more energy than the negative terminal. If the graphite electrode of the welding arc is made the positive terminal, energy will be ruinously consumed and the resulting higher temperature will increase the loss of carbon through excessive oxidation and vaporization. Moreover, the resistance well known to those familiar with the phenomenon of arc formation, a very unstable arc is obtained with the iron parent metal functioning as the negative electrode. The graphite electrode should therefore always be connected to the negative terminal, reversal of polarity being detected when the arc is difficult to hold and when the carbon becomes excessively hot.

PLUG
Figure 1. A plug weld is one used to connect the metals by welding through a hole in either one plate "A" or both plates "B". Also used for filling through a hole only, as at "C", or for added strength when

fastening fixtures to the face of a plate by drilling a countersunk hole through the fixture, [illegible] and applying the welding material [illegible] thereby fastening the fixture to the plate at that point.

"RACO"
Trade name for mild steel and covered electrodes for electric welding, soft iron rods for oxy-acetylene welding, and composite electrodes. Made by Reid-Avery Company, 1434 Brandywine Street, Philadelphia, Pa.

REINFORCED WELD
Reinforced is a term applied to a weld built [illegible] section layer of the [illegible] material is material as at "A" or "B" or when used for a corner as at "C". The top of final layer should project above a plane of 45 de-

grees to the adjoining material. This 45 degrees line is shown "dotted" in "C." This type is chiefly used in a "strength" or "composite" kind of weld for the purpose of obtaining the maximum strength efficiency and should be specified by the designer, together with a minimum number of layers of welding material.

RESISTANCE WELDING
Concentrating the welding heat at the point or points to be welded by means of resistance other than air or gas resistance. Resistance welding includes butt welding, seam welding, spot welding, and all types of welding where contact is made and pressure is applied just previous to the moment of fusion. The cycle of operation in this type of welding is in general: Pressure on, current on, current off, pressure off, and hence no arc results unless there is a very imperfect contact.

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"RACO"
Trade name for mild steel and covered electrodes for electric welding, soft iron rods for oxy-acetylene welding and composite electrodes. Made by Reid-Avery Company, 1434 Brandywine Street, Philadelphia, Pa.

WHAT is a "Raco" electrode? Who makes it? Where is it made? The welder who hears someone mention this electrode will ask these three questions. And the Welding Encyclopedia will answer them.

This Coupon will bring you a copy of The Welding Encyclopedia on approval.

Order it Now.

The Welding Engineer Publishing Co.,
608 S. Dearborn St., Chicago, Ill.

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I want one of the first copies of The Welding Encyclopedia. Please send me a copy as soon as it is off the press. I understand that I may keep it for five days for examination and I agree to send back the book or remit five dollars five days after receiving it.

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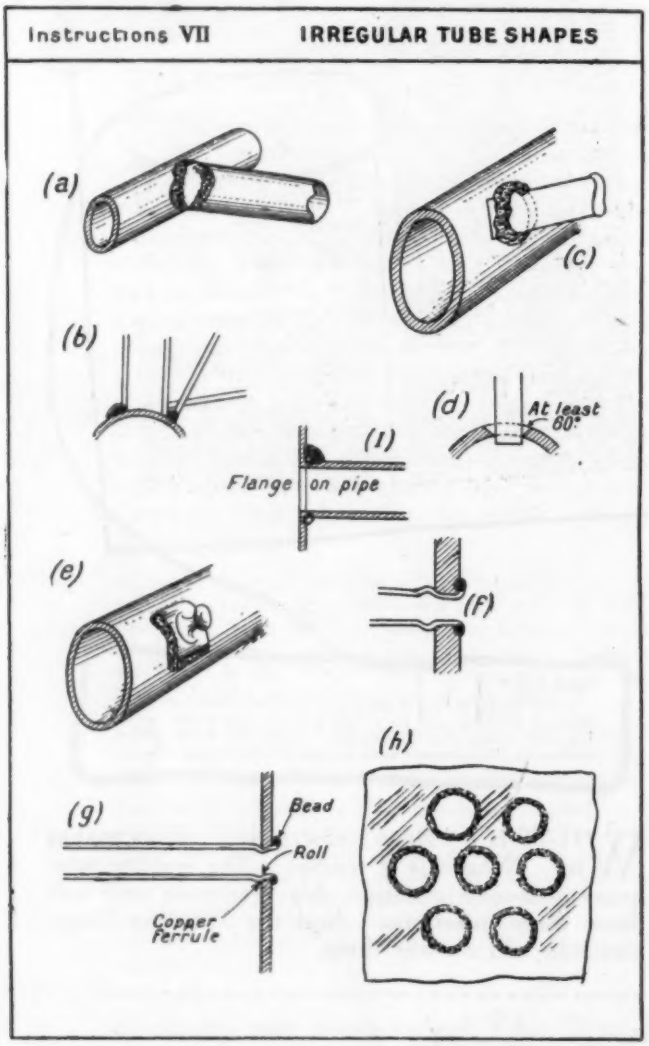
WELDING IRREGULAR TUBE SHAPES*

ONE of the most useful applications of arc welding and one that cannot be met by competition of any kind is the welding of odd shape "T's," crosses, flanges and branches in pipe shapes, whether for complete strength or strength and leakage, or simply for leakage only. Figures A and B show the simplest method of accomplishing a joint for a branch "T" of angle fitting to a pipe in which a hole is cut out of the pipe of approximately the inside diameter of the branch on tube to be fitted and the tube to be fitted is roughly cut to shape, to fit the rounded end of the pipe to be welded to. When the word roughly is used, it means that careful fit is not necessary, *i. e.*, ⅛ to ¼ in. spaces, hills and valleys will cause no trouble as they can be equalized by allowing for them when welding. For instance, electric cutting whether with the graphite arc or with a special coating electrode gives results good enough.



When welding the branch to the main pipe, it should be tacked in three or four places, else in welding one side the other side will cock up unduly out of line. In welding round the edge of the pipe, it is best to roll the main pipe into such a position that the joint to be sealed is at the horizontal bottom of the two edges to be welded, as it will be noted that pipe welding offers the additional chance of the metal running away along the rounded edge of the pipe in your direction, and especial care and a close arc continually must be held so that the metal is actually deposited in to the crater equally on both parts to be welded, and that the electrode must alternatively face as shown in Figure B, at approximately right angles to both.

It will be noted, in welding a pipe of smaller sections to one of larger, that the heat of the arc must be kept more of the time on the larger section so that the two dissimilar sections will be heated up approximately equal. On this job as in butt welding, where there is a dissimilarity of sections, the color of the weld and adjacent metal directly after depositing the metal gives a sure clue as to whether a satisfactory weld is being made. For instance, for good welding the color and the large section adjacent is not, that means a good weld has not been made in the large section. If the weld has a red color and the other two are different colors a good weld has not been made into either section, because when a weld is made there is provision for the heat of the weld to immediately conduct itself into the adjacent parent metal. The weld and both adjacent parent pieces would be the same approximate color immediately after and during welding; if not, no weld.

Figures C and D show a slightly more difficult method of making these joints; to be used where very careful work is required, such as a superheater, or other structure carrying heavy pressure. The preparation in general must be much more careful than in the preceding method, *i. e.*, while the smaller tube to be welded is not prepared at all the larger mentioned header must be veed out, so that the bottom of the hole approximately fits the outside of the pipe to be welded, and this hole must be countersunk or cut carefully with a gas torch so that there is an angle at least equal to 60 degrees between the pipe to be inserted and the parent metal of the large header. The pipe is then inserted so that it extends ⅛ to $\frac{3}{16}$ through the hole and welded as in butt welding, single "V" single bevel, but with a large angle and the pipe rolled into the horizontal position, then welded in, and there is no need of chipping off the small protruding end as experience has shown that no scale or soot results. In rolling and beading tubes oil is used, and this oil must be burned out of the sheet so that no trace of it remains under the bead, or in welding the oil-gas will bubble out through the weld causing leaks and no job. The edge of the bead and flue sheet should be cleaned of scale by chipping or sand blast, the latter being the better, but not always available.

Figure I shows a simple way of applying a flange or collar to a pipe or special shape, where the collar or flange is simply slipped over the pipe to the point desired and welded as a tee-joint, as explained in detail in Instruction 6. If a sealing joint for tightness only is desired, a single bead in the corner only is necessary, as shown on the lower part of the sketch, Section I. If both tightness and strength are desired, either a large bead applied by spreading over the first bead can be applied, as shown in the upper part of Sketch I, or a full fillet can be applied, as explained in last paragraph of Instruction 4. In welding on a rounded surface, as on a pipe, the safest method is to weld from the side upwards, rolling the pipe towards you after the flange or collar has been securely tacked in two or three places.

**Instruction No. 7 from the handbook of the Electric Arc Cutting & Welding Co., 222 Halsey Street, Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.*

NEW CANADIAN DEVELOPMENT.

The sensational development of Canadian industries in pre-war days was a weak and toddling growth compared to the mighty strides the Dominion is making industrially today. From 1905 to 1915 the capital invested in Canadian factories increased more than 135 per cent and the value of factory products advanced roughly from $700,000,000 to $1,400,000,000. It would be rash to attempt an estimate of Canada's industrial growth since 1915, but it is not a guess to assert that the Dominion has forged ahead industrially as never before in its history.

One of the most important recent announcements bearing on Canada's future industrial development is that of the Dominion Oxygen Company, Limited's promised erection of a chain of great oxygen plants for separating oxygen from the atmosphere. The first of these plants will be situated in five of the Dominion's industrial centers, and service stations will be established throughout Canada to supply oxygen users wherever there is a demand for the gas, either on or off the railroad.

The first of these plants has already been completed at Toronto, and it is said to be the largest oxygen plant ever built in Canada. It will supply the Canadian market through an extensive warehousing system, pending the erection of the additional plants. The sites for these additional plants have been secured at Montreal, Winnipeg and other points, so that the work of construction may be prosecuted as rapidly as possible.

It is perhaps unnecessary to comment on the high purity of the oxygen the Dominion plants will produce, as high purity is now generally understood to be essential in industry and may safely be accepted as the rule where it was once the exception. It may be observed, however, that in the matter of service the new company has made provision to create a new standard in its field and will be prepared to fill its orders in one or one thousand cylinder lots within 24 hours, and where orders are received in the forenoon shipments will be made the same day. An ample supply of cylinders, all new and made in accordance with specifications approved by the Canadian Board of Railway Commissioners, has been provided in advance. These cylinders are of a special type and are said to be so constructed that they are both lighter and stronger than the old type cylinders, being designed to reduce the freight to the consumer without sacrificing but actually increasing the cylinder strength. In the matter of users' agreements, too, the new company has adopted a more liberal contract form than the rather iron-clad instrument Canadian consumers have become accustomed to in time past.

The effect of the development of the Dominion Oxygen Company, Limited, is far greater than appears in a casual survey. Large as is the investment, important as is the factor of added employment of labor, and considerable as is the commodity value of the product—these, material as they are, represent but a very small measure of what this development is destined to mean. Of recent years oxygen has come to be almost as much the breath of life to industry as to the human body. Unless one has been in a position to observe the extent to which oxygen is used with acetylene and other gases, in modern welding and cutting of metals and the almost universal application of these processes to present day manufacture, construction and repair of pretty nearly everything metallic, it will be difficult to conceive how vitally the Dominion Oxygen Company, Limited's enterprise ties in with the ultimate development of Canadian industries.

TEXAS WELDER SHOWS GOODS

From Texas comes a contribution of special interest to welders in the automotive field. G. J. Rodieck sends in the accompanying photographs of work performed recently in his shop:

Figures 1-A and 1-B show an automobile truck aluminum crank case that was broken so badly that ten fragments and a missing part four inches square had to be welded and built in to effect the repair. The damaged case is clearly illustrated in 1-A and the completed repair in 1-B, which acquits Mr. Rodieck as a welder and artisan of no mean qualifications. From the expression of his face one gathers that he is satisfied with his work and is not afraid to tackle anything in its class. It is to be regretted that Mr. Rodieck did not include details as to jigs and the welding operation, as aluminum castings present some of the most interesting

1-A. A Badly Broken Aluminum Casting.

and difficult problems in the oxy-acetylene welding field.

While Mr. Rodieck neglected to include time and cost data and operating particulars, there is sufficient ocular evidence that the broken parts were reclaimed at a very small fraction of the expense replacement would have entailed.

1-B. The Torch Made the Casting as Good as New.

Mr. Rodieck was a welder in the railway service before opening his own shop, and he is unusually well equipped by experience to make a success of his business. He states that work he did four years ago in the fire-boxes of locomotives, including patches, welding of cracks in flue, crown and door sheets, etc., is in service to-day and is standing up as well as the undamaged parts. His work on superheater flues was done in what he regards as record time, and he asserts that it will hold until the flues "rot out."

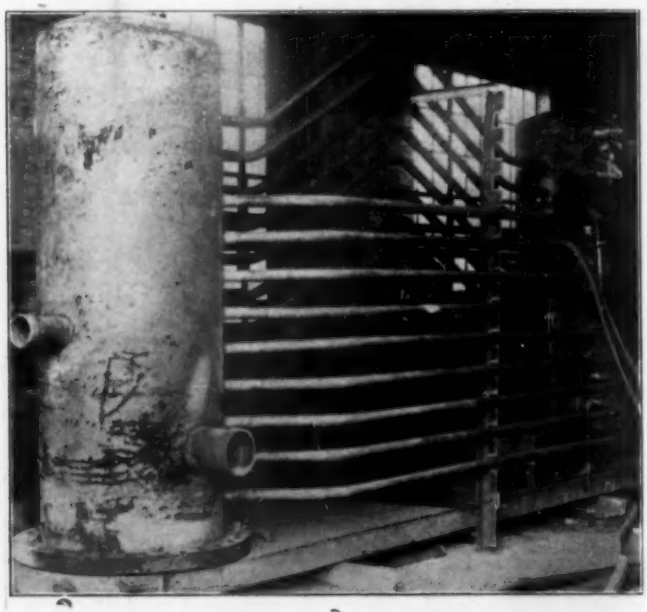
AN INTERESTING PROBLEM IN CONTRACTION

An unusual contraction problem arose recently in connection with the pipe welding on 54 large gasoline condensers for the Texas Company. Each condenser consists of four large forge-welded drums and seventy lengths of extra heavy 2 in. pipe. The drums are open at one end and flanged so that they may be bolted or riveted together after the pipes are welded in.

The pipe welding is being done by the Oxweld Acetylene Company at the welding shop of that company's Newark plant. The original plan called for straight piping in line of center between each lateral pair of drums and bent or bowed piping to connect the sides. As the distance between the drums had to be exact to meet the foundation specifications and to insure coincidence of the flanges and bolt or rivet holes of one set of drums with the corresponding points in its mates, the im-

portance of properly handling the contraction problem is at once apparent.

The engineers of the Oxweld Acetylene Co. recommended the substitution of bent piping for the straight piping noted. The theory as to contraction control was tested on both the straight and the bent pipe. Accordingly a heavy cast iron jig was made, to which the drums were made fast in the proper positions with heavy bolts. The contraction when the straight pipe was used was so powerful that the bolts were sheared off by the pull on the drum, the contractions amounting to several inches. When the bent pipe was used instead of the straight pipe this did not occur, the bent pipe accommodating itself to the contraction so completely that when the drums were removed from the jig they were found to be in correct position, fitting perfectly with the mating pairs.



Bending the Pipes Solved This Contraction Problem.

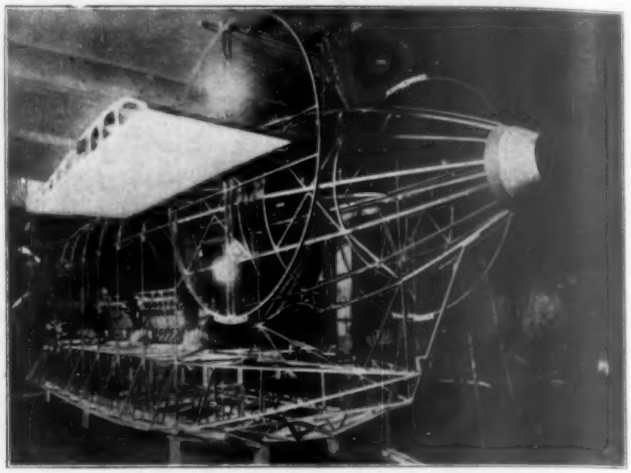
The application of the bent piping is clearly shown in the accompanying photograph. After the welding the condensers are tested to a hydraulic pressure of 500 pounds per square inch. In one of these tests a 3-in. cast iron cap bolted to one of the drums gave way, but the pipe welds in every instance stood the test without a break or a leak appearing, clearly demonstrating the remarkable strength of the oxy-acetylene welds to resist unusual pressure strains. There are of course 35 pipe welds in each drum and 140 in each complete condenser, a total of 7,560 welds in the 54 condensers.

When completed the 54 condensers will be shipped by water to Galveston, Tex., from which port they will be transported inland a distance of 150 miles to the oil fields, where they will be used in the distillation plant for recovering gasoline from natural gas and crude oil.

AERIAL ENGINEERS SPECIFY WELDED JOINTS

What will be the largest flying boat of its type in the world is being built by the International Aerial Navigation Company, of St. Louis, Mo. When completed the big amphibian will have a carrying capacity, including its own weight, of 26,000 pounds and an air speed of 200 miles per hour. When ready for the air (or water) the structure and motors will weigh about 6,000 pounds, giving a net carrying capacity of approximately ten tons.

To secure a maximum of strength and rigidity with a minimum of dead weight, International engineers conducted a series of tests that resulted in the use of nickel steel tubing for the frame and sheet aluminum for encasing the fuselage. After selecting the materials exhaustive tests were made to determine the strongest joints possible to obtain, as it is necessary to make joints that will withstand vibration as well as tensional strains. The result was the adoption finally of oxy-acetylene welding.



This Frame is Nickel Steel Tubing.

The accompanying illustration shows the welded construction very clearly and gives an excellent view of the two 450-H. P. Liberty 12 Packard airplane motors with which the ship is equipped. The fuselage is cigar-shaped, the dimensions being 42 feet long by 8½ feet wide and 9½ feet high. The cratt, which is technically known as a Tandem Monoplane Flying Boat, is said to be much stronger and lighter than any other plane having equal lifting surface and power.

OXY-ACETYLENE APPLICATIONS IN FOUNDRIES

The oxy-acetylene department in the modern foundry is now as much a matter of course as the pattern shop or finishing room. The blowpipe is the accepted tool for cutting off steel risers because of its economy and speed, and in all welding operations such as filling in of blowholes and building up of defective castings it is indispensable as a source of saving and especially because the oxy-acetylene weld, being free from hardspots, contributes to ease and finish in machining.

Repair of broken castings, while not so important in the foundry as elsewhere, because patterns are usually available for making new castings and because the material costs are not so high as in completed machinery, is nevertheless quite common wherever castings can be welded more cheaply than they can be replaced. This is frequently the case and has led to provision being made in most foundries for preheating whenever the welding is to be done in places where the application of a welding heat will set up stresses in the casting.

The modern foundry lends itself admirably to the production of quality acetylene welding. As a rule annealing ovens are ready to hand for the initial preheating; brick and coke are pesent for the building of ovens to provide final heating and annealing; and men who are experienced in the control of expansion and contraction are always at hand to supervise the work.

In many foundries special spaces are set off for the welding and cutting operations. An ideal procedure, where ample floor space is available, is to remove the castings from the molds, take them to a regular place for rough cleaning, next to a separate space for cutting off of risers, and finally to the grinders for finishing, where the defective

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The goggle allows unobstructed vision and is "roomy" enough to keep fresh air moving in front of the eyes. It is durable and can be sterilized by any method; never becomes hot and any part can be replaced without a tool. Perhaps you know this goggle by its other name, Style LI. Surely you know of its fine record and wide use in modern welding. Why not use it?

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castings are sorted out for removal to the welding division. A very orderly and simple mode of handling the castings is to use storage-battery trucks, cranes or monorail hoists carrying separate frames for the loads. In this way the frames may be loaded where the work is done, special work being kept to itself, and the loaded frames picked up and deposited in the spaces assigned for succeeding operations.

Acetylene may be supplied either by generator or cylinder, and oxygen may be taken from individual cylinders or from a pipe line fed from a manifold. In building new foundries it is advisable to use welded pipes for the distribution of gases, and to install welded air pipes and welded sandblast machines. Large diameter pipe used with either low pressure exhaust or supply fans should be welded to prevent leaks, which cause daily waste in the additional power required for the make-up at the fans. An extra half hosepower saved soon pays for the entire system, and welded pipe is both cheaper and better than riveted pipe.

Numerous controversies are constantly being brought before foundry managers as to the merits of various oxygens, methods of generating acetylene, fuel gases other than acetylene, and apparatus for using the gases. Founders generally are accepting the conclusion that the manufacturers of equipment and supplies whose business is old-established and national in scope are best qualified to advise the consumer and best equipped to render him dependable service. Unless the founder is equipped to conduct his own tests he can hardly do better than to accept the representations of the manufacturer who has an unquestioned record of success to vouch for the excellence of his product, the efficiency of his process and his ability to serve the customer.

The many ways of handling oxy-acetylene applications in the foundry illustrate the wonderful flexibility and adaptability of the process. Mention has been made of the cutting of steel risers. This may be done on the foundry floor where the castings are poured, or the work may be done at a specially assigned place. Filling in of blowholes, building up defective castings and repair of broken castings have also been noted. There are numerous other things that can be done with oxy-acetylene or oxygen, such as scaling castings, cleaning ladles, burning salamanders, welding pipes, tools, structural shapes, machinery guards, etc.

In scaling castings a welding flame is applied to the refractory silica scale, which has a different expansion from that of the iron and cracks very readily just as does the enamel of a bathtub when heated, making it very easy to remove. This application does away with hammering and is a great time saver. It also tends to make easier labor conditions in the foundry.

Oxygen is used very successfully in clearing refuse metal and slag from electric and gas furnaces. It is much better than using bars and sledges in cleaning up, is easily and cheapily applied, and contributes to neatness in the foundry.

When any steel work is bent out of true it is surprising how easily it can be bent back into form by playing a large oxy-acetylene welding flame over the metal and using a sledge after a red heat is attained. This applies to both structural and sheet steel.

Worn out or broken steel parts can be replaced or repaired by welding. Excellent pipe joints can be made and should always be welded where vibration is very pronounced. Machinery guards, safety rails, etc., are being made constantly by welding. The value of oxy-acetylene for tinkering around any plant having a machinist is such that a separate portable outfit should be kept for the repair or emergency gang. The machinist who is assigned to this kind work should be provided with literature on welding and cutting. The machinist should also read the current numbers of *The Welding Engineer* to keep his foundry thoroughly abreast of the times in the late developments in welding practice.

Many foundries assign production welders to do odd jobs. This almost always results in retarding production. It is much better to have a regular shop master mechanic look after the shop work. For most of the work which requires expert manipulation competent men are now generally available.

Finally, it should be borne in mind that while repairs to broken castings, even those of moderate size, occupy considerable time and floor space, they are in a great many instances sources of savings that more than justify the practice. The use of oxy-acetylene in the foundry is susceptible of further profitable development.

WANTED: A FLANGE PULLEY, QUICK!

Editor:

Welding shops are about the last resort for the customer that can not procure what he wants some where else. Here is a concrete case:

About a month since, a customer of ours came to our plant and asked for a light flange pulley. The pulley wanted was to have dimensions as follows: Main diameter 2¾ inches, flanges 4½ inches and sufficiently wide between flanges to carry a 3-inch belt. This pulley to be crowned.

After looking over our scrap pile, we told our customer that nothing in stock would answer. He said: "I must have the pulley." Now I have found that it pays to accommodate a customer, so I said I can make a pulley such as you describe; but it will cost more than one made from stock. "Price is no object, provided I get what I desire," was his reply. I told the customer to call the following morning and get the pulley.

I then proceeded to scrap up the wheel. My method was as follows: The center was made from a piece of 2½-inch black iron pipe, cut off in a lathe and faced to 3⅛ inches in length; the flanges were cut out of a piece of steel plate ½-inch thick and a hub was cut off 1¼-inch long by 1½-inch diameter; this hub was drilled to ⅝-inch; both flanges were bored in the center; but one was bored slightly larger than the hub which was to be welded into it.

We were now ready for the welding. The hub was welded into the flange; welding being done on the inside. The next operation consisted of drilling three ⅜-inch holes in each flange about equal distances apart, on the pipe circle. Now the two flanges and pipe were bolted together lightly and tacked together through the holes, being careful to weld into the pipe rim. The wheel next was heated and all joints brazed and allowed to cool.

After the pulley had cooled, it was chucked in our lathe and the holes rebored to size; it was then driven on a mandrel and machined all over; hub was set screwed and the pulley was ready for our customer. The result astonished him. Personally, I was surprised myself. I have never in thirty years' machine shop experience seen a better pulley for the service for which it was intended. This job brought prestige to our shop.

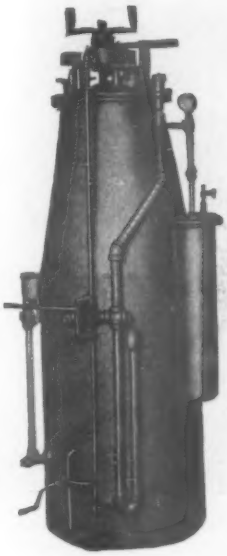
D. S. Myers.

CHICAGO SECTION MEETS NOV. 24th.

The American Welding Society, Chicago Section, will meet Wednesday evening, November 24th, at the rooms of the Western Society of Engineers. The program will be general discussion of a welding problem.

The Metal & Thermit Co., San Francisco, is planning the erection of a new plant in South San Francisco, to include a general manufacturing plant, a welding shop, a works building, and a power house.

Acetylene 1¼c per foot



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"Weld-a-cast" adheres readily to the hot welding rod which picks up just enough and none is wasted; it does not blow away but melts at once; it eliminates blow holes and leaves the metal soft.

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This is the only complete book on the "Why" and "How" of Welding

Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.

Gives principles never to be forgotten. Aluminum, cast iron, steel, copper, brass, bronze and malleable iron are fully treated, as well as a clear explanation of the proper manner to burn the carbon out of the combustion head.

Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

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THERMIT WELDING TIMELY DURING FREQUENT BREAKDOWN PERIOD

The following illustrations are of interest in showing certain examples of recent large thermit repairs on a variety of iron and steel parts, made during the recent period of unusual activity in heavy welding.

Figures 1 and 2 show a large emergency thermit repair of a

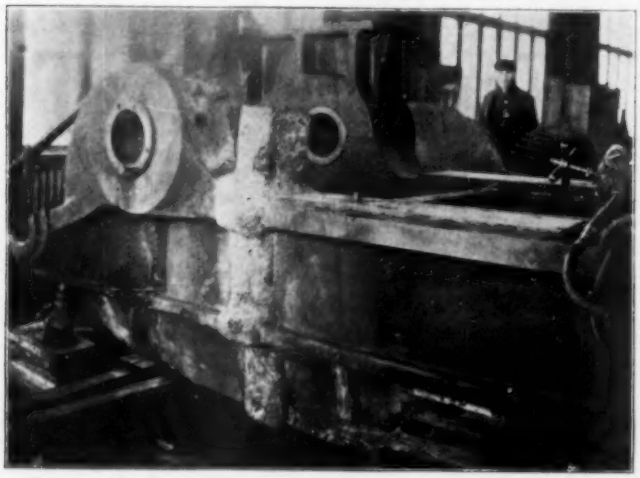


Fig. 1. Thermit Repair of Cast Iron Bulldozer.

cast iron bed frame of a bulldozer for the Magor Car Corporation, Passaic, N. Y. The section at the break varied in measurement from about 4 in. x 14 in. at one part to about 8 in. x 21

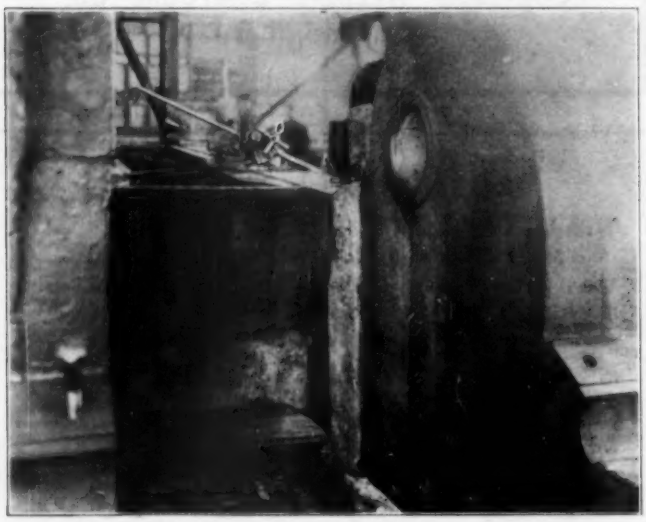


Fig. 2. Inside View of Weld on Bulldozer.

in. at the thicker part. Although cast iron sections are more difficult to weld than steel sections, on account of the fact that the thermit steel on cooling contracts twice as much as cast iron,

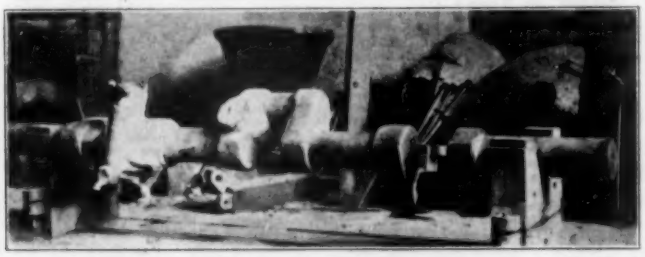


Fig. 4. Two Thermit Welds on Crankshaft.

the repair in question was found to be perfectly feasible owing to the chunky section involved and the work was simplified because the part broken off happened to be a free end. Six hundred pounds of cast iron thermit (or plain thermit with which is mixed a 3 per cent Ferro Silicon 50/50 and 20 per cent mild steel punchings) were used for making the weld. An inspection of the finished repair showed a very good weld and the alignment of the sections welded came within 1/32 in. of perfect.

Fig. 3. Extension Billet Welded Onto the End of a Crankshaft.

Figure 3 shows an extension billet weld on to the end of a crank shaft for the Public Service Electric Co.

Figure 4 shows two welds made on a crank shaft for the Mingo Junction Water Co., Mingo Junction, Ohio.

ONE WAY TO AVOID THE FLAG POLE HAZARD

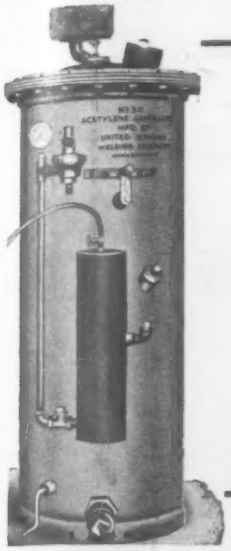
"It is high time our patriotic Americans were learning something about flag poles," says a Chicago steeplejack, commenting on a timely article, "The Flag Pole Hazard," in June issue of *Safety Engineering*. Continuing he says:

"You can't stop people putting up flagstaffs, but a little education on the subject won't hurt anybody and might keep somebody from getting hurt. If the folks who put up these sticks climbed as many as I do to paint them, you can bet they'd want them safe.

"The trouble with the old-style wooden staff is rotting, and it works at both ends—at the top where an iron rod is generally stuck in to hold up a ball or some other ornament, and at the bottom where the butt is buried. The wood rots and the iron rusts and in a few years the pole is bound to get shaky.

"Metal poles may be all right, and then again they may not be. If they are riveted the rust will eat out the rivets and weaken the seams. The only safe pole for long service seems to be the iron pipe kind, not one with screwed connections. That makes the joints weaker and picks up rust the same as the riveted joints. The pole should be made of pipe of assorted diameters, so the ends can be slipped in and socketed like a jointed fishing rod. And then the joints should be welded in tight with the oxy-acetylene blowpipe. This makes the joints stronger than the pipe and a smooth weld doesn't give the rust any place to get a hold as it does in the seams around rivets and screw threads.

"I painted a 105-foot pole for the Crane Company not long ago in Chicago. It was of this welded pipe construction and had been standing for between five and six years. There are plenty of risks in my work without being careless, so I looked the staff over pretty thoroughly before starting the job, and by the time it was finished there was not a spot from top to bottom that I didn't see. It was in perfect condition at every joint. It is good looking, too, tapering from about eight inches at the base to two-and-a-half inches at the tip.



Are You Prepared?

You may have the finest welding or cutting equipment in the world and yet not be prepared to give prompt service if without gas. Acetylene generators eliminate the possibility of ever being out of gas.

"U. S." Generators are so simple that a boy can operate; are extremely efficient and will save about 80 per cent of your acetylene bill. They will operate any make of welding or cutting apparatus.

A machine to make 150 cubic feet per charge.....$175

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"One might think the wooden pole is cheaper, but I doubt it. It is certain that the welded pole is cheaper than the riveted pole and is just as cheap as the screwed connections, and in the long run it makes the cheapest and most satisfactory staff to be had. It would be a good thing to make the welded pole standard and do away with this kind of hazard altogether."

The same advantage that is pointed out for welding construction of flagstaffs applies with equal force to smokestacks. The life of the riveted smokestack is comparatively limited, owing to oxidation or rusting of seams and rivets, which necessitates replacement of sections from time to time. The susceptibility of even the slightest crevice to rust is well known, especially to shipbuilders, and oxy-acetylene welding is now recognized as the best means of preventing rust in joints.

In the matter of flag pole construction, any average welder can handle the work on the ground where the staff is to be reared. All he needs besides the proper pipe lengths and sizes is a portable welding outfit.

BRAZING STEEL TUBES

Some manufacturers of steel tubing are using a method of brazing the seams in the tubes that does the work quickly and produces a very satisfactory joint. One of the processes adopted consists in placing the tubes in lots of a dozen or more on a movable rack. The joints are first veed as shown

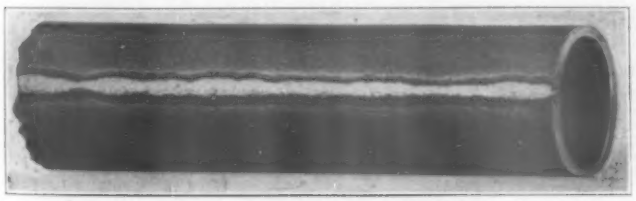

Fig. 1. Showing Mixture of Flux and Spelter.

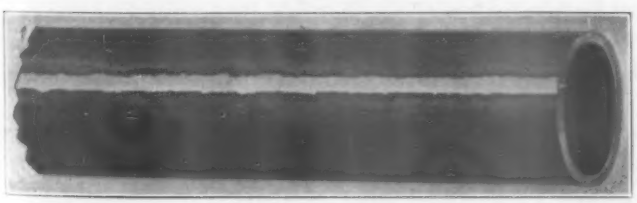

Fig. 2. The Joint After Leaving the Furnace.

in Figure 1. This is the most practical joint for pipe brazing because such joints are easily cleaned and also easily loaded with flux and spelter. They simplify the process of brazing because the heat is applied from above instead of below. Figure 2 shows the mixture of flux and spelter applied and ready for the furnace. The flux used in this instance is known to the trade as fluxine. Tubes prepared in this manner are put into the furnace and brought to the brazing heat. Their appearance after leaving the furnace is shown in Figure 3. The flow of the spelter is even and confined to the joint and the low heat required has not caused scales on the metal. The tube sanded and polished, showing a solid, smooth joint, is illustrated in Figure 4. The mixture used

Fig. 3. Polished Tube, Showing Smooth Joint.

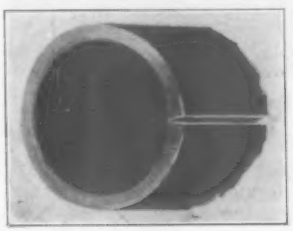

Figure 4.

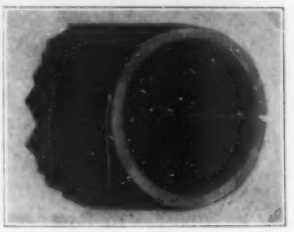

Figure 5.

in brazing this pipe was made in the proportion of twenty-five pounds of fluxine and one hundred and forty-four pounds of spelter. One pound of this mixture was required to braze one hundred feet of one-inch tubing. Figure 5 shows the inside of the pipe after brazing with a smooth even flow of spelter all through the joint. Steel tubing brazed in this manner, for the manufacture of metal beds for example, can be bent ninety degrees without affecting the joint.

GENERATOR STANDS FIRE TEST*

The wisdom of the fire underwriters in cautioning the public against any other than approved types of acetylene generators was again demonstrated in a shop fire at Houston, Texas, in the plant of Horton & Horton.

The fire started in an adjoining shop and worked its way to the welding department, where everything but the generator, of the 50 lb. pressure type, was an utter loss. The fire was so intense that it melted all of the brass parts and destroyed all piping, filter, regulators, etc., in fact ruining everything above the waterlines in the equipment. The dark belts in the illustration indicate the water-protected areas in the generator and back-pressure valve. The generator was

fully charged at the time of the fire and had been in use just previously. When reached by the flames it was carrying a full head of gas. The excessive heat weakened the spring in the pop valve, after which the vent remained open, the gas igniting and flaring out in a flame several feet in length, but the water seal prevented the fire from flashing back into the generating chamber. Spectators stood back at a respectful distance, fearing an explosion momentarily, but apparently there was no danger.

The Generator Didn't Explode.

Authorities on acetylene generation declare that only the safety features characterizing approved apparatus prevented a disastrous explosion.* This generator was, or is—for it is back in commission now—one of those that has the formal approval of the underwriters' board.

**It should be none the less borne in mind, however, that under no circumstances should anyone assume that it is safe to approach an acetylene generator with an open flame.*

WELDING IN MEXICO

Editor:—In a recent issue of *The Welding Engineer* you asked for pictures so I am sending you one that I had taken at the

Some Mexican Welders.

shop of the Compania de Minerales Y Metales, S. A. at Mapini, Durango, Mexico. I am working for this company as electric welder and instructor in arc welding. We find that the Mexicans are very apt pupils and that they make good welders.

CHRIS. BURNS.

KINKEAD WITH MITCHELL CO.

Robert E. Kinkead, welding engineer for the Lincoln Electric Company, Cleveland, has resigned to associate himself with A. F. Mitchell & Son, engineers and electric welding contractors, foot of Orleans St., Chicago.

Robert E. Kinkead.

Mr. Kinkead graduated from Ohio State University in 1913 (M. E. and E. E.) He immediately became active in the welding industry, in the welding department of the Lincoln Company, with whom he has been connected ever since. He is credited with having introduced the use of inductive ballast in circuits for electric arc welding. During the war he served as a lieutenant in the navy, having completed a special course of training at an officers' school at Annapolis.

NICKEL WELDING RODS

The Electrical Alloy Company, of Morristown, New Jersey, are placing on the market welding rods made of pure nickel and certain special nickel alloys, intended for use in operations where a weld of high strength, toughness, and ductibility is essential.

Various other metals, such as copper, manganese, silicon, etc., are alloyed with the nickel in different proportions, the range of composition extending from 99 per cent nickel to 45 per cent nickel. The series of alloys shows melting points ranging from 1500° C to 1200° C, and accordingly materials can be selected from the series, to apply to a wide range of welding practice.

The distinguishing characteristics of these alloys are resistance to oxidation, and fluidity when molten. They do not rust nor corrode at ordinary temperatures, and are oxidized with great slowness even when molten.

Renewal Not-Repair

The Lawrence Patent process is the only way of economically—and dependably—repairing your scored cylinders.

It is fully protected by its patents—and in vital respects differs entirely from any apparently similar methods of achieving the same end. It has never been known to fail; no scored cylinder repaired by the Lawrence process has ever given out.

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We have a large quantity of brand new welding and cutting hose. Will sell for less than the factory charges for it. This hose was in a warehouse in which there was a fire, and we bought it from the insurance companies. It is guaranteed absolutely perfect and brand new.

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Before me, a notary public in and for the State and county aforesaid, personally appeared L. B. Mackenzie, who, having been duly sworn according to law, deposes and says that he is the publisher of the The Welding Engineer and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing Editor, and business managers are:
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2. That the owners are (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)
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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is. (This information is required from daily publications only.)

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[SEAL.] Stella I. Lindquist.
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CURRENT WELDING LITERATURE

REPORT OF COMMITTEE ON ELECTRIC WELDING, (A. R. E. E.)—It has been demonstrated that certain jobs can be safely and economically welded and excellent equipment is available for all forms of autogenous welding. The requisites to success are proper materials, rules and methods for their use, and intelligent application of the process.—Railway Electrical Engineer, October.

RAPPORT DU SERVICE DES ESTABLISSEMENTS CLASSES—The use of dissolved acetylene for autogenous welding has always been considered as exempt from all danger. It is necessary, however, to enforce rigidly the existing rules for bottling acetylene and using bottled gas.—Journal de L'Acetylene, September.

BACKWARD WELDING, by Marcel Piette.—The torch should be held at a constant angle and the welding rod given a light movement across the line of the weld. The flame is held halfway to the bottom of the bevel to permit more rapid fusion and execution. The method gives a weld of minimum width and uses a minimum amount of filling material. Its special application is found in welding sheet metal.—Revue de la Soudure Autogene, September.

AUTOGENOUS WELDING OF ALUMINUM.—Characteristics of the metal are low tensile strength at the melting point and rapid oxidization. Care must be taken to have no strain on the heated parts. The use of a suitable flux is recommended.—La Saldatura Autogena, September.

MANUFACTURING CITROEN AUTOMOBILES. APPLICATIONS OF OXY-ACETYLENE WELDING. Applications of welding fall into two classes; the making of joints between parts and the reclaiming of defective castings. The illustrations in this series show the various types of equipment used and some of the parts that are joined by welding.—Acetylene and Welding Journal, September and October.

IDEALS OF THE WELDING SCHOOL, by W. B. Purdue.—Welders require skillful training, for they cannot master the art by studying alone. But he should be taught the principles of welding so thoroughly that he will be able to explain and illustrate to the instructor before actually starting the work. He should be impressed with the importance of being honest with himself, and thinking for himself.—Acetylene Journal, November.

THE OXYGRAPH.—Booklet published by Davis-Bournonville Co. showing some details of mechanically operated cutting torches, and a variety of shapes cut in electrical works, shipyards, navy yards, tool shops and manufacturing plants.

WELDING RAIL JOINTS TO OBTAIN FLEXIBILITY.—Along the head of the rail the plate and rail are fused or welded together continuously for a distance of 6 in. each side of the rail joint leaving an unwelded length of about 8 in. at each end of the plate. Along the base of the rail the plate is welded for a 10-inch length on either side of the joint, but leaving a gap at the joint about 3 in. wide, and about a 3 in. unwelded length at each end of the plate.—Electric Railway Journal, October.

EXAMPLES OF ARC WELDING JOBS. By Ethan Viall.—Arc welding has been used extensively in shipbuilding and railroad work. It has an important application in flue and firebox welding. The article includes general rules for arc-welding, and information on loading tests and the speed of welding.—American Machinist, Oct. 14.

WELDING A BROKEN FLY WHEEL, by David Baxter.—Description of the oxy-acetylene welding process as it was applied to repairing a cast iron fly wheel that had two spokes broken near the rim. It also includes general hints and suggestions for welding cylindrical cast iron bodies.—American Blacksmith Auto and Tractor Shop, October.

NEWS ITEMS

Welding equipment was displayed at the twelfth annual convention of the Association of Railway Electric Engineers, in the Auditorium Hotel, Chicago, October 19-22 by General Electric Co., Westinghouse Electric & Mfg. Co., Transportation Engineering Corp., and the Safety Car Heating & Lighting Co.

The export department of the Oxweld Acetylene Company has been removed to the Carbide and Carbon Building, New York City. It was formerly located in the factory at Newark, N. J. Mr. R. G. Noble is now in charge of the department.

CONCERNING WELDING TESTS

Editor:

In the August *Welding Engineer*, I note an article in reference to some tests, which were carried out by the Algona Steel Corporation, Ltd., of Sault Ste. Marie, Canada. So far as I can tell either these fellows are competing with an electric arc welding man and they are not using common sense or else they do not know anything about electric arc welding. Anybody that can't beat 18,000 pounds to the square inch with an electric weld on steel, don't know anything about welding. I am not complaining to you about that matter, however, because I am very much in favor of publishing data on tests which have been made with the welding process. However, I believe that in a case of this kind where the results obtained are obviously far below the lowest obtained by anybody who does electric arc welding, that some comment should be made which would indicate that these tests are not typical of the results obtained with the electric arc welding process.

Yours very truly,

R. E. Kinkead.

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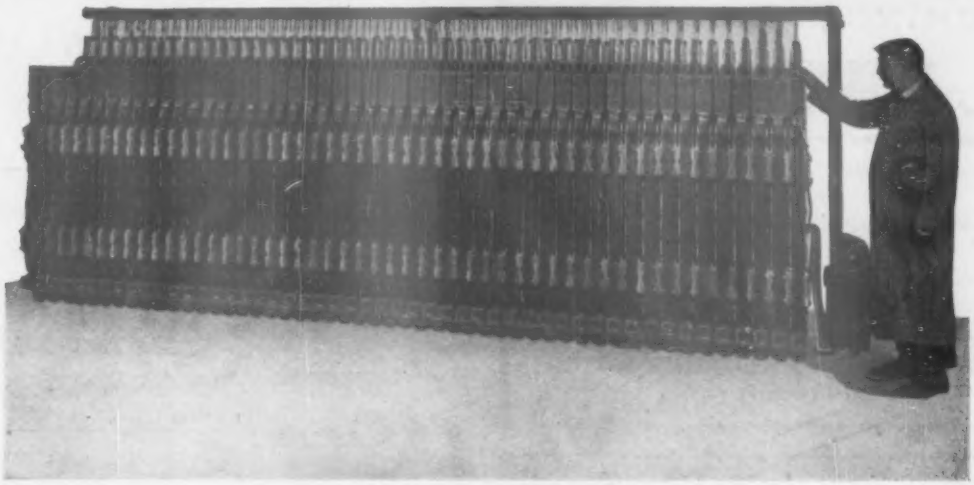

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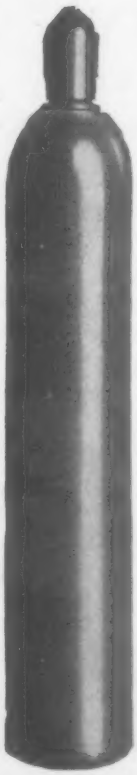

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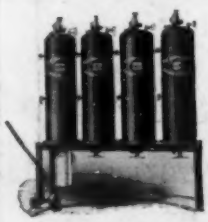

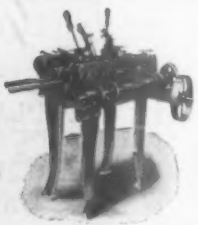

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